The Devon Active Villages Evaluation (DAVE) trial of a community-level physical activity intervention in rural south-west England: A stepped wedge cluster randomised controlled trial

Submitted by Emma Louise Solomon to the University of Exeter
as a thesis for the degree of
Doctor of Philosophy in Sport and Health Sciences
in October 2013

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……..

ABSTRACT

Background: Although physical inactivity has been linked with numerous chronic health conditions and overall mortality, the majority of English adults report insufficient physical activity. To increase population physical activity levels, researchers have called for more community-level interventions. To evaluate these complex public health interventions, innovative study designs are required. The aim of this thesis was to evaluate whether a community-level physical activity intervention—'Devon Active Villages'—increased the activity levels of rural communities.

Methods: The Devon Active Villages intervention provided villages with 12 weeks of physical activity opportunities for all age groups. Community engagement helped tailor activity programmes for each village; communities were then supported for a further 12 months. 128 rural villages from south-west England were randomised to receive the intervention in one of four time periods, as part of a stepped wedge cluster randomised controlled trial. Data collection consisted of a postal survey of a random sample of adults (≥18 years), at baseline, and after each of the four intervention periods. The primary outcome of interest was the proportion of adults who reported sufficient physical activity to meet the current guidelines (≥150mins of moderate-and-vigorous, or ≥75mins of vigorous-intensity activity per week). The number of minutes spent in moderate-and-vigorous activity per week was analysed as a secondary outcome. Using data from all five periods, a comparison of study outcomes between intervention and control arms was performed, allowing for time period (as a fixed effect), and the random effect induced by correlation of outcomes (clustering) within villages. Additionally, the baseline data were analysed

separately using logistic and linear regression models to examine the correlates of physical activity behaviour in rural adults.

Results: *Baseline study:* 2415 adults completed the postal survey (response rate 37.7%). The following factors both increased the odds of meeting the recommended activity guidelines and were associated with more leisure-time physical activity: being male, in good health, greater commitment to being more active, favourable activity social norms, greater physical activity habit, and recent use of recreational facilities. In addition, there was evidence that younger age, lower body mass index, having a physical occupation, dog ownership, inconvenience of public transport, and using recreational facilities outside the local village were associated with greater reported leisure-time physical activity.

Main study: 10,412 adults (4693 intervention, 5719 control) completed the postal survey (response rate 32.2%). The intervention did not increase the odds of adults meeting the physical activity guideline, although there was weak evidence of an increase in the minutes of moderate-and-vigorous-intensity activity per week. The ineffectiveness of the intervention may have been due to its low penetration—only 16% of intervention participants reported being aware of the intervention, and just 4% reported participating in intervention events.

Conclusions: *Baseline study:* This study highlights potentially important correlates of physical activity that could be the focus of interventions targeting rural populations, and demonstrates the need to examine rural adults separately from their urban counterparts.

Main study: A community-level physical activity intervention providing tailored physical activity opportunities to rural villages did not improve physical activity levels in adults. Greater penetration of such interventions needs to be achieved

for them to have any chance of increasing the prevalence of physical activity at the community level.

ACKNOWLEDGEMENTS

There are many people who have made this research project possible, and I am eternally grateful to every single one of them. First, I would like to thank my supervisors, Associate Professor Melvyn Hillsdon and Dr Tim Rees, for all their guidance, assistance, and many a wise word over the last three years. I would also like to thank Dr Obioha Ukoumunne and Dr Brad Metcalf for being my statistics gurus, and teaching me so much about regression analyses (and football). This research project would never have been possible had it not been for the hard work of Professor Tim Coles in organising the Economic and Social Research Council PhD CASE Studentship, so thank you very much. To Active Devon for being fantastic business partners, by always being available to deal with my requests, and for placing high importance on the research project, I thank you. Additional thanks go to Lee Moore for putting up with me when I am grumpy, and for listening to me yabber on about writing my thesis for the last year. Finally, I would like to thank my parents, Nicola and Michael Solomon, for always supporting me, looking after me with good food and good company, and for always being interested in my research (even if you did refer to my thesis as an essay!).

LIST OF CONTENTS

LIST OF FIGURES AND TABLES

Chapter 6

LIST OF APPENDICES

LIST OF BIBLIOGRAPHY

DEFINITIONS AND ABBREVIATIONS

Definitions

Physical activity – any bodily movement produced by skeletal muscles that requires energy expenditure.

Physical inactivity – lack of physical activity.

Recommended physical activity guidelines – adults are recommended to undertake a minimum of 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity physical activity per week.

Rural – all population, housing, and territory not included within an urban area. Typical rural areas have a low population density and small settlements. Rural settlements are usually classified by having a population of less than 10,000 people.

Sedentary – sedentary behaviour refers to activities that do not increase energy expenditure substantially above resting level (sleeping, sitting, lying down, watching television). A sedentary lifestyle is a type of lifestyle with no or irregular physical activity.

Abbreviations

BMI – body mass index

BRFSS – Behavioral Risk Factor Surveillance System

CDC – Centers for Disease Control

CHAMPS – Community Health Activities Model Program for Seniors

CI – confidence interval

CLAHRC – Collaborations for Leadership in Applied Health Research and Care

Coeff. – coefficient

CPAQ – Children Physical Activity Questionnaire

d – Cohen's d (expected difference between the means between an experimental group and a control group)

DAV – Devon Active Villages

DAVE – Devon Active Villages Evaluation

ESRC – Economic and Social Research Council

GEE – generalised estimating equation

HR – heart rate

ICC – intra-cluster correlation coefficient

IMD – Indices of Multiple Deprivation

IQR – interquartile range

IPAQ – International Physical Activity Questionnaire

IPAQ-SV – International Physical Activity Questionnaire – Short Version

Kg – kilogram

KPAS – Kaiser Physical Activity Survey

LAA – Local Area Agreement

LTPA – leisure-time physical activity

m^2 – metres squared

MAQ – Modifiable Activity Questionnaire

MET – metabolic equivalent

MET/min/week – metabolic equivalent minutes per week of physical activity

MVPA – moderate-to-vigorous-intensity physical activity

N – number

NIHR – National Institute for Health Research

NPHS – National Population Health Survey

OR – odds ratio

p – p-value (probability of obtaining a test statistic)

PA – physical activity

PAR – 7-day Physical Activity Recall

PCT – Primary Care Trust

Pop – population

PRISMA – Preferred Reporting Items for Systematic Reviews & Meta Analyses

Ref – reference

RPAQ – Recent Physical Activity Questionnaire

RR – relative risk

SD – standard deviation

SQUASH – Short Questionnaire to Assess Health Enhancing Physical Activity

t – test statistic for T-tests

TV – television

U15 – under 15 years

US NHIS – United States National Health Interview Survey

X^2 – Chi square statistic

y – years

CHAPTER 1.

Introduction

Leading a physically active lifestyle reduces the risk of all-cause mortality, cardiovascular disease, type two diabetes, and some cancers, and can improve musculoskeletal health, control body weight, and reduce symptoms of depression (World Health Organization, 2009). In order to achieve such benefits, adults are recommended to undertake a minimum of 150 minutes of at least moderate-intensity physical activity per week (Department of Health, Physical Activity, Health Improvement and Protection, 2011; World Health Organization, 2010). Despite this, in the Health Survey for England 2008, only 39% of men and 29% of women reported doing sufficient physical activity (Craig, Mindell, & Hirani, 2009). Based on this evidence, interventions to increase physical activity levels are now considered to be as important to population health as interventions to lower tobacco use or reduce blood pressure (Department of Health, Physical Activity, Health Improvement and Protection, 2011). Fortunately, substantial health benefits can be achieved through relatively modest changes in physical activity among large segments of the population (Kohl et al., 2012).

Physical activity is a complex behaviour determined by the interaction of a large number of personal, social, and environmental factors (Oliveira-Brochado, A., Oliveira-Brochado, F., & Quelhas Brito, 2010; Sallis & Owen, 1997; Trost, Owen, Bauman, Sallis, & Brown, 2002). In order to change population prevalence, interventions need to be both effective and reach large numbers of people. The majority of physical activity interventions have been

delivered at the level of the individual, aimed at changing personal behaviour (House of Lords: Science and Technology Select Committee, 2011), whereas it is community-level interventions that have the potential to produce long-lasting benefits for the whole community (Merzel & D'Afflitti, 2003). To date, evaluations of community-level interventions have typically used weak study designs, such as uncontrolled, pre-post evaluations, and are therefore unable to attribute any observed changes to the intervention (Baker, Francis, Soares, Weightman, & Foster, 2011). A 'Behaviour Change' report by the House of Lords (House of Lords: Science and Technology Select Committee, 2011) noted that pragmatic community-level interventions funded by public money are routinely delivered with little or no evaluation. The report stated that there is no excuse for weak evaluations, with the recommendation that rigorous evaluation plans should be in place before interventions are funded (House of Lords: Science and Technology Select Committee, 2011).

Although 20% of the English population (approximately 10 million people) live in non-urban locations (Craig et al., 2009), rural populations are generally understudied (Ogilvie et al., 2010; Saelens, Sallis, & Frank, 2002). Studies examining the influence of residential location on physical activity have generally found that rural adults are less likely than urban adults to meet recommended activity guidelines, suggesting rural residents are appropriate targets for future physical activity interventions (Bertrais, Preziosi, Mennen, Galan, Hercberg, & Oppert, 2004; Brownson, Eyler, King, Brown, Shyu, & Sallis, 2000a; Martin, Kirkner, Mayo, Matthews, Durstine, & Hebert, 2005; Parks, Housemann, & Brownson, 2003; Wilcox, Castro, King, Housemann, & Brownson, 2000). It is clear that rural populations face a unique set of

challenges associated with physical activity behaviour, and yet they have received very little research attention to date, especially in the United Kingdom.

‘Devon Active Villages’ was a community-level physical activity intervention delivered to 155 rural communities across Devon, southwest England. The intervention was designed and coordinated by Active Devon, the countywide partnership for sport and physical activity. The primary objective of the Devon Active Villages intervention was to improve participation in physical activity by offering people of all ages increased opportunities to experience the enjoyment of sport and physical activity. Each village received a ‘community engagement phase’ for twelve weeks prior to the main intervention. During this phase, delivery partners engaged with local people and community groups to carry out a needs assessment and an assessment of the activities currently on offer. This often included local people being directly surveyed to find out what activities they wanted the Devon Active Villages intervention to provide. The intervention then delivered twelve weeks of physical activity opportunities for people of all ages, with each village receiving at least three different types of activities (e.g., basketball for primary school children, multi-sports sessions for adolescents, and fitness classes for adults). The activity sessions were subsidised using intervention funds. Community volunteers were recruited to help run the activities and were provided with mentoring support throughout the intervention. Delivery partners supported the villages for twelve months following the intervention, providing them with specialist support, regular mentoring, as well as additional funding and equipment as required to help sustain the intervention activities.

It is fundamental that interventions, such as Devon Active Village, are rigorously evaluated, because large amounts of public money is spent on

community-level interventions every year, and therefore it is vital that we have a clear understanding of whether the funded interventions are effective at changing physical activity behaviour at the community-level. If a particular intervention (e.g., Devon Active Villages) was found to be effective, then it would be plausible to suggest that more money should be spent on rolling out similar interventions across the country, rather than continuing to spend money on different interventions, with little or no idea about which interventions are actually working and why.

Therefore, the overall aim of this PhD thesis was to evaluate the effectiveness of the 'Devon Active Villages' community-level physical activity intervention. In this chapter I discuss how the PhD research study came into fruition, the main aim of the study, and how the research was funded. I then introduce the Devon Active Villages intervention, discuss how the intervention was funded and delivered, and present the intervention goals for behaviour change. Additionally, I investigate why physical activity interventions are so important to population health, in terms of the disease risks associated with being physically inactive, and the current low physical activity prevalence rates.

1.1 Origins of the PhD research study

As a centre of excellence for sport, leisure, and tourism research, the University of Exeter was selected by the Economic and Social Research Council (ESRC) to be a national 'Capacity Building Cluster'. The ESRC is a public funding body committed to supporting research of economic and social relevance. The cluster was funded by the ESRC with a grant of £1.5 million for five years of research (2008-2013). One funding route within the cluster was for 15 PhD CASE Studentships, giving the students an opportunity to gain

experience of work, outside academia, through collaboration with businesses or organisations on research problems relevant to the partner. The students would be supported by both academic and business supervisors. The main PhD funding would be provided by the ESRC, with an additional £4k per annum contributed by the business partner.

After discussions between Active Devon and Dr Tim Rees, a successful PhD Studentship grant of £69,000 was attained from the ESRC. Active Devon is the Devon county partnership for physical activity and sport. Active Devon was the business partner for this PhD CASE studentship, wanting a PhD researcher to evaluate the effectiveness of a new county-wide intervention—Devon Active Villages. In addition to the ESRC grant, circa £20,000 of funding was obtained for the evaluation data collection costs. Funding was obtained from the National Institute for Health Research (NIHR) Collaborations for Leadership in Applied Health Research and Care (CLAHRC) and from the University of Exeter, in the form of a Business Voucher, Research and Knowledge Transfer Link Fund, and from the department of Sport and Health Sciences. After interviewing for the position, I was fortunate enough to be awarded the PhD Studentship.

1.2 The Devon Active Villages intervention

In April 2009, Sport England, the government body for sports promotion, announced a time-limited funding programme targeting rural communities. The ‘Rural Communities’ programme aimed to address barriers and create new opportunities for participation in sport in rural communities. Sport England wanted the programme to be as flexible as possible, welcoming applications either to modernise or enhance sporting facilities, provide revenue funding for any aspect of sports development, or a combination of the two. The overall aim

of the investment programme was to develop projects that encourage people living in rural communities to participate and/or sustain their participation in sport, and help those with talent to fulfil their potential. Nationally, £10 million of National Lottery money was available for the programme, and Sport England received 517 applications totalling circa £150 million.

Active Devon, with support from many relevant local partners (e.g., Devon County Council, 5x30 Countywide, Community Council for Devon, Devon Playing Fields Association, among others) submitted an application to fund an ambitious rural outreach intervention called Devon Active Villages. Active Devon believed that by working together with local partners Devon Active Villages could have more widespread impact, meet the needs of the highest priority communities and make a significant contribution to Local Area Agreement (LAA) targets. In February 2010, Active Devon secured £500k of funding from Sport England to rollout Devon Active Villages, with Devon County Council providing the remaining funds to cover the overall intervention costs (circa £950k).

Devon Active Villages, as an activity intervention, aimed to support village communities to provide long-term sustainable sports participation opportunities. Active Devon positioned the Devon Active Villages concept in the introductory/informal sport segment of the market and was aimed at getting people into sports participation. The intervention was designed neither as a specific public health initiative to deliver health based physical activity interventions, nor a ‘sports excellence’ intervention aimed at identifying talented performers who wish to engage in serious competition. Although both of these may have been incidental outcomes, the main aim was to offer people

opportunities to experience the fun of sport, and in doing so build a lifelong love of being active and healthy.

The primary objective of the intervention was to improve people's rates of participation in sport and physical activity (any bodily movement produced by skeletal muscles that requires energy expenditure; Caspersen, Powell, & Christenson, 1985). There were also a number of secondary outcomes of the intervention; such as developing strong, sustainable and cohesive communities, improving health and reducing health inequalities, improving the life chances and focussing the energies of children and young people, creating safer communities by reducing anti-social behaviour, and increasing skills and prosperity. Therefore, the intervention principally addresses Sport England's GROW objective: getting one million people doing more sport, and working with the Youth Sport Trust to offer young people at least five hours of high quality sport per week.

In total, the Devon Active Villages intervention was delivered to 155 village communities (Figure 1-1). Prior to the main intervention, Active Devon ran a pilot period with 15 villages, the outcome of which was used to inform the main intervention protocol. The remaining 140 villages that were not part of the pilot received the intervention in one of four periods. The intervention was planned to last for three and a half years from April 2010 to September 2013. The Devon Active Villages intervention had an offer for people of all ages from primary school children to adults.

The Devon Active Villages intervention was targeted at parish communities with between 500 and 2000 residents. These population boundaries were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities

they offered. Approximately 157,000 Devonians live in the parish communities that the intervention intended to target, with 117,500 of these people being aged 18 years or older. It was anticipated that there would also be a broader impact on those people living in smaller surrounding communities. This would be due to individuals from smaller communities, where there are often no recreational facilities, regularly travelling to the larger villages to partake in sport and physical activity.

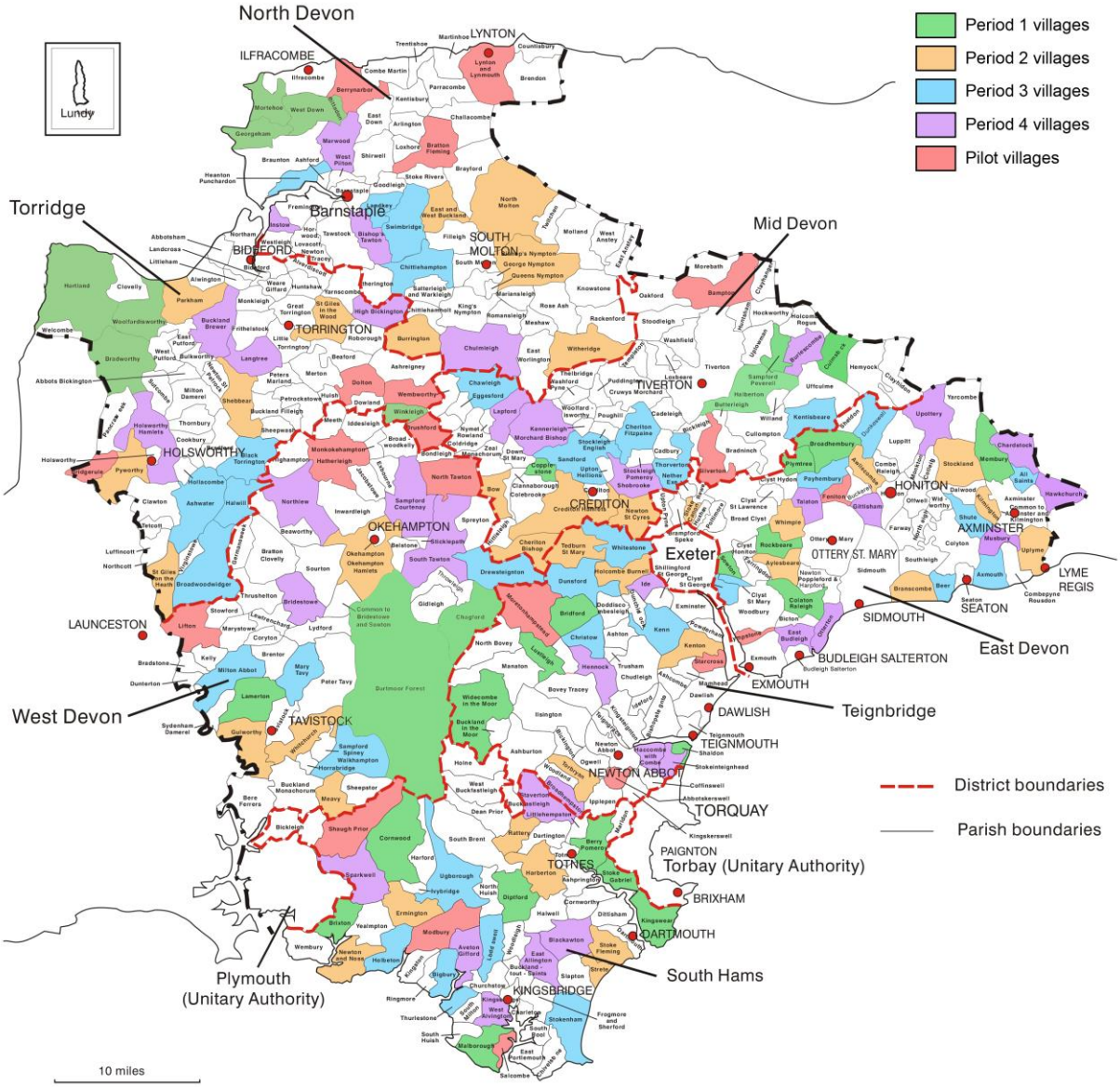


Figure 1-1 Map of Devon parishes indicating the intervention villages targeted at each period.

1.2.1 Sport England's track record of evaluation

One report from the British Heart Foundation Health Promotion Research Group presented the findings from research commissioned by Sport England to review existing research and practice on improving health through sport (Cavill, Richardson, & Foster, 2012). One of the aims of the report was to help Sport England align their sporting programmes with health priorities. The report found that the evidence base for the effectiveness of interventions for the specific promotion of sport is far less developed than for the promotion of physical activity (Cavill et al., 2012). Some published evidence is available to suggest that sport can engage inactive people at an individual or group level, with increased success when targeting individuals who were willing and ready to change their behaviour. Nine UK case studies provided evidence that sport can reach inactive people, especially if the programmes include the targeting of inactive people and are properly marketed, planned, and delivered appropriate to the needs of the target group by empathic motivating leaders. However, while the case study review showed that there are some approaches to monitoring that are effective, it also revealed that the majority of activity in this area is relatively unfocussed. Data management has been shown to be poor in many cases, several projects started collecting data and then stopped, and other projects collected data but did not analyse it. Therefore, the report concluded that Sport England should ensure that its projects increase the quality and quantity of monitoring and evaluation activity (Cavill et al., 2012).

1.2.2 Delivery of the Devon Active Villages intervention

Active Devon oversaw the strategic roll out and co-ordination of the intervention. To ensure the intervention reflected the diversity that exists within Devon's districts and village communities, local delivery partners from each of the seven regions of Devon (East Devon, Mid Devon, North Devon, South Hams, Teignbridge, Torridge, and West Devon) were employed to deliver the intervention in each district. Local delivery partners included district authority sports development teams and community-based charitable organisations, some of which manage local facilities, as well as maintain and develop activity opportunities in the local area. It was necessary to have different local delivery partners for each region due to the large number of villages receiving the intervention in each period, and because the villages were spread across the whole county (Figure 1-1). No one local delivery partner was of sufficient size to cover the whole county.

Each local delivery partner was given strategic support from Active Devon. Local delivery partners received a 'Devon Active Villages Project Plan' (Appendix A), which provided a clear framework and timescales around the delivery of the intervention, with a strong focus on generating a local need led approach to designing the activities. The local delivery partners also received a bespoke 'Engagement and Consultation Guide' (Appendix B) for the Devon Active Villages intervention to help them provide expert sport and physical activity development support to each community. The guide provided familiarisation training for all development workers involved in the intervention. The guide also included details of support available, self-help resources to provide to communities, scheme minimum operating standards, details of

progression routes available in the relevant locality, and an outline framework for provision of sports development support within the intervention.

The established framework of ‘Community Physical Activity and Sports Networks’ in Devon was used to ensure that key local partners such as local authorities, school sports partnerships, voluntary sports clubs, other voluntary sector agencies, and primary care trusts (PCTs), were fully involved with the delivery of the scheme. Sports’ National Governing Bodies and local stakeholders throughout Devon contributed to the development of the intervention, and played a critical role in the delivery of local opportunities.

Prior to the main intervention being delivered, each village received a twelve-week ‘Development Support Phase’ (Figure 1-2). During this time, local delivery partners provided specialist support through engaging with local people, elected member structures, schools, and other community groups. A local needs assessment was carried out, as well as an assessment of the activities currently on offer, and the activities’ take-up and capacity. This often included individuals being directly surveyed to find out what activities they would have liked the Devon Active Villages intervention to provide.

The main intervention period followed, with each village receiving twelve weeks of physical activity sessions, and at least three different types of activities. The Devon Active Villages intervention typically consisted of an after school club aimed at primary school children, a youth sports offer for secondary school children, an adults’ programme offering fitness and exercise-based sessions, as well as multi-sport sessions. Intervention funds were used to help support the establishment of activities (e.g., equipment, coaching, facility hire). Local delivery partners coordinated the delivery of the intervention by finding suitable activity venues, purchasing necessary equipment, and hiring local experts to

deliver the activities. The local delivery partners also advertised the Devon Active Villages activity sessions using local media (e.g., newspapers, posters, leaflets, village newsletters). Community volunteers were recruited to help run the activities, and provided with mentoring support throughout the intervention. Villages were given access to bespoke ‘self-help’ resources, such as promotional support and materials, on-line toolkits, and activity starter packs.

Each village was then supported for a further nine months following the intervention. Local delivery partners helped the communities to sustain the intervention activities, by providing support, regular tailored follow-up mentoring for the volunteers, and additional funding or equipment if necessary. Additionally, local people were offered coaching qualifications to help the villages continue the activities independently. There was also the opportunity for villages to become involved in 2012 Olympic Legacy events, and potentially receive an ‘Active Villages’ award at the Devon Sports Awards.

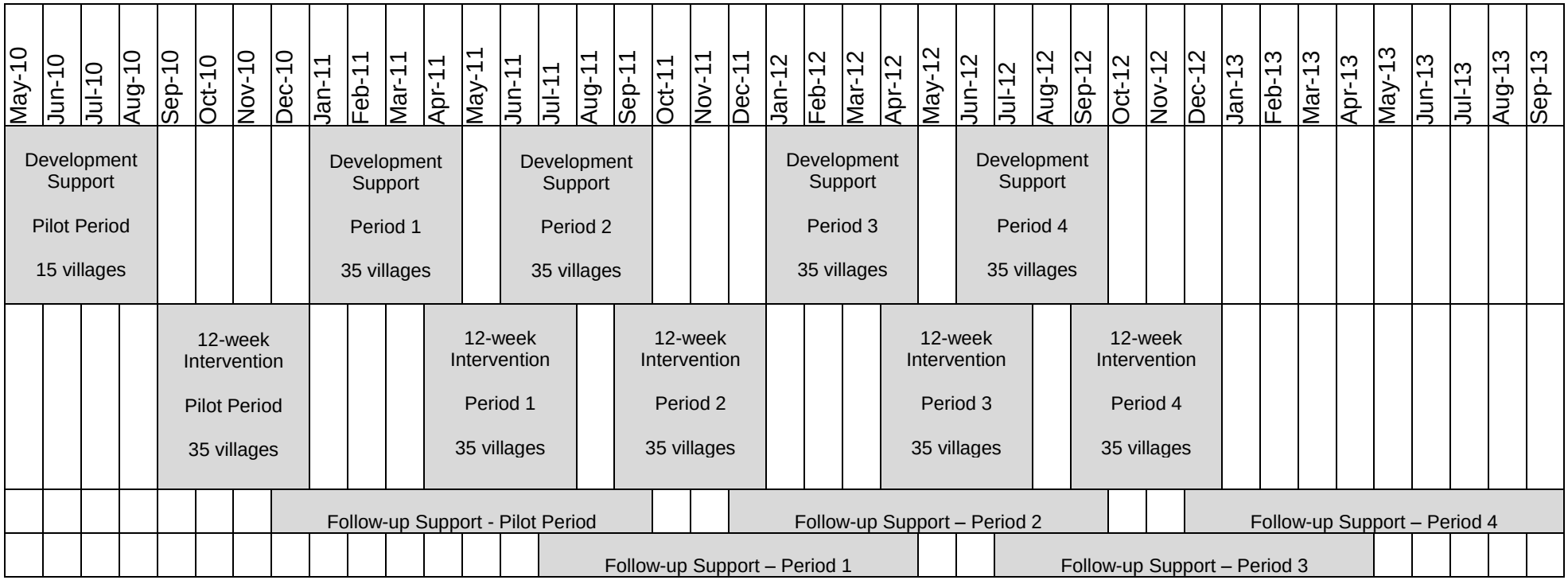


Figure 1-2 Devon Active Villages intervention delivery timetable—May 2010 to September 2013.

1.2.3 Goals of the Devon Active Villages intervention

Through working with local partners and ‘supporting’ rather than just ‘providing’, Active Devon proposed that the delivery model would help lay the foundations of sustained community activity. It was also proposed that sustainability of the intervention would be enhanced through the fact that all age groups were to be actively engaged with the intervention, and that the village communities had a strong ‘sense of community’, and ethos of self-help. Research suggests that strategies to engage and empower communities during health promotion interventions are promising in their ability to produce health impacts (Swainston & Summerbell, 2008; Wallerstein, 2006). One of the principle components of the intervention was that the local communities themselves had power in the decision-making processes about which sports and physical activity opportunities would be most appropriate for their community. Although there was a need for Active Devon to satisfy external funding agencies that consistent outcomes would be achieved across the area, the solutions identified locally were likely to have differed depending on the prevailing local circumstances.

One of the main goals of the Devon Active Villages intervention was to improve participation rates in physical activity, in line with the Devon ‘Local Area Agreement’ (LAA; www.devon.gov.uk/index/councildemocracy/partnershipworking/local_area_agreement.htm). Active Devon aimed for the intervention to have the following impact on participation and contribution to the Devon LAA targets:

(1) 7,136 participants aged 16 years and over, including 3,023 participants who are currently active less than 3x30 minutes per week.

(2) 5,143 participants under 16, including 492 5-16 year olds who are currently identified as taking part in less than 3x30 minutes of activity per week (beyond the curriculum).

(3) 12,279 participants in total.

Target figures were based on the following assumptions:

(1) Participants aged 17 and over—3% of the population of target communities participating in the programme, with an additional 1% of the population participating each year.

(2) Participants aged 5 to 16—16.7% of children from target communities participating, with 30% growth in the number of participants each year.

1.2.4 Devon Active Villages intervention monitoring

Active Devon monitored the intervention implementation by asking each participant to complete a registration process prior to participating in any activity sessions as part of the Devon Active Villages intervention. The registration form asked participants for information on their gender, age, ethnicity, any disabilities, education level, postal address, email address, and physical activity level. The registration process included a rewards card scheme, where participants were provided with an incentive to complete the initial registration, and further incentives to complete a follow-up questionnaire twelve months later.

1.3 Working with Active Devon

In addition to the monitoring and evaluation work described above, the Devon Active Villages intervention incorporated the PhD research study. Active Devon considered the research study to be a critical component of the intervention, due to it representing a rare opportunity to formally assess the

impact of Active Devon's work at the village level. They were keen to ensure that the opportunities to learn from the intervention were maximised. Active Devon wanted to understand the impact of the Devon Active Villages intervention, through identifying whether the intervention was successful in changing physical activity behaviour, as well as identifying and examining potential secondary outcomes. It was important to Active Devon to understand the 'whys' and 'how' the intervention was effective, or not so. It was also important for the research study to help identify and feedback best practice during the intervention implementation. The research study was also framed in such a way that if the Devon Active Villages intervention was found to be effective, it could have potentially supported an evidence-based proposal for continuation of investment from wider partners after the Sport England investment concluded.

Throughout the implementation of the intervention I worked in close liaison with Active Devon. Active Devon provided me with updates on the intervention delivery, activities offered in each village, and any issues encountered with the intervention delivery. Process data from the research study were fed back to Active Devon throughout the intervention, to aid best practice in the implementation of later intervention stages. I also assisted Active Devon with the development of their participant registration form, and the item used to measure physical activity.

1.4 Health profile for Devon

The health of adults in Devon is generally better than the England average (Department of Health, 2010). Life expectancy for both men (79.6 years) and women (83.6 years) in Devon is higher than the England averages

(77.9 and 82.0 years respectively). Deprivation is significantly lower in Devon (4.6%), in terms of the proportion of people who live in the 20% most deprived areas of England (England average: 19.9%; Department of Health, 2010). Over the last ten years, all cause mortality rates, as well as early death rates from cancer, heart disease, and stroke have fallen, and are significantly better than the England average (Department of Health, 2010). Estimated levels of adult 'healthy eating', smoking, binge drinking, and physical activity are all significantly better than England averages (Department of Health, 2010).

1.5 Physical activity

Physical activity is defined as any bodily movement, produced by skeletal muscles, that requires energy expenditure (Caspersen et al., 1985). The dimensions of physical activity include frequency, intensity, duration, and type. The different domains of physical activity include work, transport, domestic duties, and during leisure-time. In low-income countries most activity occurs during work, while in high-income countries most activity occurs during leisure-time (World Health Organization, 2009).

Moderate-intensity physical activity involves exercise or activities that are hard enough to increase the pulse rate and induce sweating, but not so hard that talking is no longer possible. Examples of moderate-intensity activities include walking to and from work, cycling, gardening, and jogging. Vigorous-intensity physical activity involves exercise or activities that result in significant increases in pulse rate, make you feel out of breath, and find it difficult to conduct a conversation, for example swimming, running, muscle-strengthening exercises, and team sports.

1.5.1 Disease burden of physical inactivity

In developed and many developing countries physical inactivity is one of the most important public health problems of the 21st century (World Health Organization, 2009). There is strong evidence linking physical inactivity with various chronic conditions, including cardiovascular disease, high blood pressure, type 2 diabetes, stroke, obesity, metabolic syndrome, several cancers, and mental health problems (Department of Health, Physical Activity, Health Improvement and Protection, 2011; World Health Organization, 2009). In fact, physical inactivity is estimated to cause about 30% of ischaemic heart disease, 27% of type 2 diabetes, and around 21-25% of breast and colon cancer burden (World Health Organization, 2009). Physical inactivity has been identified as the fourth leading risk factor for global mortality, estimated to cause 6% of all deaths (World Health Organization, 2010). Lee et al. (2012a) estimated that elimination of physical inactivity would increase the life expectancy of the world's population by 0·68 (range 0·41-0·95) years.

In the United Kingdom, physical inactivity is estimated to cost the National Health Service in excess of £0.9 billion per year (Scarborough et al., 2011). Physical inactivity also creates costs for the wider economy, through absence from work and early mortality, estimated to cost in excess of £1.6 billion per year (Unit DoCMaSS, 2002). In 2002, physical inactivity was directly responsible for 3% of disability adjusted life years lost in the UK (Allender, Foster, Scarborough & Rayner, 2007). In Devon, 18% of all deaths in 2010 could have been prevented if all adults were sufficiently physically active (Public Health England, 2010).

1.5.2 Physical activity prevalence rates in England

In order to reduce the risk of these diseases, adults are recommended to undertake a minimum of 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity physical activity per week (Department of Health, Physical Activity, Health Improvement and Protection, 2011; World Health Organization, 2010). However, in England, only 39% of men and 29% of women reported doing sufficient physical activity to meet the minimum recommended guidelines in 2008 (Craig et al., 2009). In south-west England, self-reported physical activity was slightly higher than the English average, with 42% of men and 32% of women reporting sufficient physical activity to meet the recommendations in 2008 (Craig et al., 2009).

The proportion of adults in England meeting the physical activity recommendations fell with age for both sexes (Craig et al., 2009). This decline was steeper in men, while in women the decline only became apparent in adults aged 45-54 years or older. Men in the lowest income quintile were least likely to meet the recommended guidelines (31%), with little variation in the top four quintiles. For women, there was little variation in the lowest four income quintiles, however, the proportion meeting the recommendations was highest in the top income quintile (34%; Craig et al., 2009). Men who were classified as overweight (i.e., with a body mass index (BMI) of 25 to <30 kg/m^2; 41%) or obese (BMI ≥30 kg/ m^2; 32%), were less likely to meet the recommended guidelines than men who were not overweight or obese (BMI <25 kg/m^2; 46%). Similarly, 36% of women who were not categorised as either overweight or obese met the recommended guidelines, compared to 31% of overweight and 19% of obese women (Craig et al., 2009).

Sports and exercise were the most commonly reported activity among

men (51% had participated in the last four weeks), while the least common activity was heavy manual work/gardening/DIY activities (28%). Heavy housework was the most commonly reported activity for women (59%), and heavy manual work/gardening/DIY activities were the least common (12%; Craig et al., 2009). For both sexes, participation in walking, and sports and exercise generally fell with age (Craig et al., 2009).

Bélanger, Townsend, and Foster (2011) found the physical activity profile of typical physically active adults varied considerably according to age in England. For women, walking was the most important contributor to total physical activity, and one of the most important for all age groups in men. Domestic activities represented a large and relatively stable proportion of total activity for women across all age groups, whereas its importance increased with age in men. Occupational physical activity accounted for relatively more physical activity among the middle age categories, in comparison to the youngest and oldest adults. For both sexes, the proportion of time spent in exercise, fitness and team sports decreased markedly with age. This is suggested to be related to changes in interests, opportunities, and time constraints occurring with age (Allender et al., 2008). Participation in non-team sports, outdoor pursuits, and leisure pursuit activities was similar across age categories, however, these activities contributed relatively little time to the total physical activity of men. Similarly, team sports, non-team sports, and outdoor pursuit activities were the least important contributors among women (Bélanger et al., 2011).

All the physical activity prevalence data reported above were based on information collected from self-reported measures included in the Health Survey for England 2008 (Craig et al., 2009). Questions concerned participation during

the last four weeks in housework, manual/gardening/DIY activities, occupational activity, walking, and sports and exercise, however, active travel was not measured. As part of this survey, objective measurements of physical activity were also recorded, in the form of accelerometry. These objective measures revealed that only 6% of men and 4% of women met the recommended activity guidelines (Craig et al., 2009). Men and women aged 16-34 years were most likely to have met the recommended activity guidelines (11% and 8% respectively), and the proportion of adults who met the recommendations fell in the older age groups for both sexes. Only 10% of men and 8% of women whose self-reported activity level corresponded with meeting the recommendations, also met the recommendations based on accelerometry (Craig et al., 2009).

1.6 Physical activity interventions

Fortunately, substantial health benefits can be achieved through relatively modest changes in activity behaviour among large segments of the population (Haskell et al., 2007). Therefore, physical activity interventions are now considered to be as important to population health as other high profile interventions, such as those lowering tobacco use or reducing blood pressure (Department of Health, Physical Activity, Health Improvement and Protection, 2011). Interventions involve a combination of program elements or strategies designed to produce behaviour change or improve health status among individuals or an entire population. Interventions typically include educational approaches, health promotion campaigns, policy changes, or improvements to the environment (Kahn et al., 2002). Although the health benefits of physical activity are well-established, little is known about the effectiveness of

interventions designed to improve population physical activity (Foster, Hillsdon & Thorogood, 2005). Thus, more studies, especially rigorous evaluations of physical activity interventions have been requested to further the theoretical understanding of what makes interventions successful (National Institute for Health and Clinical Excellence, 2008).

The majority of physical activity interventions have been delivered at the level of the individual, aimed at changing personal behaviour (House of Lords, 2011). In order to change population prevalence, however, interventions need to be effective, but they also need to reach large numbers of people. It is community-level interventions, therefore, that have the potential to produce long-lasting benefits for the whole community.

Community-level interventions aim to improve the health risk factors of an entire population, for instance cities, towns, villages, schools, community centres, or in certain situations—whole countries. Such interventions provide a feasible and cost-effective way of reaching large numbers of people using limited resources (Bopp & Fallon, 2008; Garrett et al., 2011; Harding, Griffin, & Wareham, 2006). Community-level interventions are typically multi-dimensional, incorporating strategies such as mass media campaigns, mass communication (e.g., posters, flyers, websites), counselling by health professionals, collaboration with community-based organisations, use of specific community-based settings, and changes to the environment (Baker et al., 2011; Bopp & Fallon, 2008; Merzel & D'Afflitti, 2003; Mummery & Brown, 2009). Community-level interventions that actively engage with community members, partake in participatory planning, and the development of community partnerships tend to be the most effective at initiating a change in physical activity behaviour (King, Gill, Allender & Swinburn, 2011; Sallis & Owen, 2002).

Evidence as to which type of community-level interventions are most effective is currently limited (Baker et al., 2011). To date, evaluations of community-level interventions have often used weak study designs, such as uncontrolled, pre-post evaluations, and are, therefore, unable to attribute any observed changes to the intervention (Baker et al., 2011). Typically, community-level health interventions in the United Kingdom have been relatively local and small scale, with the need to obtain and retain funding the only driver for evaluation activities (Hills, 2004).

For instance, in the Devon Active Villages intervention, the only evaluation activity required by the funder (Sport England) was to report the number of participant registrations to the programme, with no indication of the number of times registrants participated in the programme, or whether there was any resulting behaviour change. Sport England set Active Devon target numbers of registrations to meet at certain time-points of the intervention (e.g., 12,227 total registrations by April 2014). These targets were also broken down by age-group (5-16, 17-19, and 20+ years). Often, the research questions of greatest interest to public health practitioners, and the policy makers who make resources available, are often not the questions that funders ask interventions to provide (Nutbeam & Bauman, 2006). This means that decision makers and practitioners can often be frustrated in finding program evaluation information that is really useful for them (Nutbeam & Bauman, 2006). Therefore, in order to improve the quality and effectiveness of health promotion interventions it is essential that researchers and practitioners can use the evidence generated through evaluation, through having a dialogue between researchers, practitioners, and policy makers to improve the relevance of research done (Nutbeam & Bauman, 2006). However, simply collecting registration numbers

provides very little evidence that can be used to guide improvements in the practical interventions that have an impact on health and the quality of life.

Therefore, to meet the growing demand for accountability, funding agencies increasingly require large-scale quantitative evaluations of the impact of public health programmes (Habicht, Victora & Vaughan, 1999; House of Lords, 2011). This, coupled with the commissioning of more large-scale community-level interventions has provided opportunities to develop novel approaches to evaluation and outcome measurement that have not been widely used in the United Kingdom previously (Hills, 2004; House of Lords, 2011).

Evaluations of community-level interventions can pose a considerable challenge, partly due to the complex, multi-levelled nature of the intervention, which makes any straightforward link between input and output extremely difficult to establish, and partly due to the inadequacy of many existing evaluation models used to capture these complexities (Hills, 2004). For instance, Jackson, Altman, Howard-Pitney, and Farquhar (1989) stated 'Evaluators face significant challenges in developing sampling, measurement, design, and implementation strategies that can survive the complexity of community intervention with enough conceptual and methodological integrity to justify the effort' (p.20).

1.7 Conclusions

In this chapter, I described how the research study was established in conjunction with the Devon Active Villages intervention. I introduced Devon Active Villages, illustrating how the intervention was delivered, the goals set for physical activity behaviour change, and how the intervention was monitored. I also described the global disease burden caused by physical inactivity, the low

levels of physical activity participation among the English adult population, and the advantages of community-level physical activity interventions for changing population levels of physical activity. Finally, I described the limited availability of evaluation studies on community-level physical activity interventions, and the need for novel study designs when evaluating complex interventions. In the next chapter, I review the different methodologies available for evaluating community-level physical activity interventions. I also describe the different methods available for measuring physical activity, discussing the strengths and limitations associated with each method. I then review the literature available on the differences in physical activity behaviour between rural and urban adults.

CHAPTER 2.

Literature reviews

In the previous chapter, I described the background behind the PhD research study and the Devon Active Villages intervention. I introduced the concept of physical activity, discussed why physical activity interventions are so important to public health, and how it is community-level interventions that have the potential to change population prevalence. Research was presented suggesting that community-level physical activity interventions are often poorly evaluated using weak study designs. In this chapter, I review the different study designs available for evaluating community-level physical activity interventions, discussing the strengths and weaknesses of each approach. Additionally, the different methods available for measuring physical activity behaviour are reviewed, and the available literature on the differences between rural and urban adults, in terms of their physical activity behaviour and associated correlates, are outlined.

2.1 Review of study methodologies for evaluating community-level interventions

There are many study designs to choose from when evaluating community-level interventions, with different designs suiting different research questions and circumstances (McKee et al., 1999). Awareness of a whole range of study designs should lead to more appropriate methodological choices (Craig et al., 2008). The level of confidence that any observed changes could be attributed to the effect of the intervention varies between study designs.

Randomisation should always be considered, because it is the most robust way of preventing the selection bias that occurs when the intervention community differs systematically from the comparison community (Eccles, Grimshaw, Campbell, & Ramsay, 2003).

It is important to choose the most relevant study design for the research question being addressed, and one that is as rigorous as possible (Craig et al., 2008). Just because a design is rarely used in a particular field does not mean it cannot be used. Study choices should instead be made on the basis of specific study characteristics, such as expected effect sizes and the likelihood of selection and other biases (Craig et al., 2008). Study designs available for evaluating interventions include randomised controlled trials, case studies, after-only designs, uncontrolled before-and-after studies, controlled before-and-after studies, interrupted time series designs, uncontrolled randomised trials, cluster randomised controlled trials, and stepped wedge cluster randomised controlled trial designs (Table 2-1). In this section, I review each of the available study designs and discuss their relevance to the evaluation of community-level physical activity interventions.

Table 2-1 Strengths and limitations of study designs

Study design	Strengths	Limitations
Randomised controlled trials	• Random samples • Control population • Baseline measures • High internal validity • Systematic differences can be ruled out • Intervention effect is the only difference between groups	• Lack of consideration for external validity • Sometimes difficult to randomly allocate people in same community • Hard to reproduce in real world • Tend to focus on individuals
Case studies	• Provide a detailed understanding of experiences and outcomes • Greater depth of data generated • Help adapt ideas and produce novel hypotheses	• Addresses a different research question • Cannot draw definite cause and effect conclusions • Usually only focuses on one individual or organisation • Risk of selection bias is high (non-random sample) • Limited external validity • Risk of confirmation bias
Uncontrolled after-only designs	• Minimal data collection • Low evaluation costs • Simple to conduct	• No baseline measures • No control population • Risk of selection bias is high (non-random sample) • Influence of secular trends not accounted for • Cannot draw definite cause and effect conclusions
Controlled after-only designs	• Control population • Minimal data collection • Low evaluation costs • Simple to conduct	• No baseline measures • Risk of selection bias is high (non-random samples) • Influence of secular trends not accounted for • Cannot draw definite cause and effect conclusions
Uncontrolled before-and-after studies	• Baseline measures • Simple to conduct • Possible to obtain measure of intervention effectiveness • Useful for evaluating immediate impact of short-term interventions	• No control population • If non-random sample used, risk of selection bias is high • Influence of secular trends not accounted for • Less useful for evaluating long-term interventions • Limited internal validity
Controlled before-and-after studies	• Control population • Baseline measures • Possible to obtain measure of intervention effectiveness • Accounts for secular trends • Strengthened by additional measurement periods	• If non-random sample used, risk of selection bias is high • 'Within group' analyses—no adjustment for baseline differences, no comparison between groups • Risk of residual confounding is high

Table 2-1 (continued)

Study design	Strengths	Limitations
Interrupted time series design	• Multiple data collection time points • Baseline measures • Can include control populations • Estimates secular trend from multiple time points pre-intervention	• Often no control population • Can be difficult and costly to implement • No protection against the effects of other events occurring simultaneously
Cluster randomised controlled trials	• Random samples • Control population • Baseline measures • Randomises groups of individuals • Minimises treatment contamination between intervention and controls • Accounts for secular trends • Appropriate for community-level interventions	• Require large sample sizes • Difficult to deliver interventions to many clusters simultaneously • Violates assumption that all study individuals are completely independent • Unethical to withhold intervention from clusters, if prior belief that intervention will do more good than harm
Stepped wedge cluster randomised controlled trials	• Random samples • Baseline measures • Controls cross-over to become intervention group • All clusters receive the intervention • Intervention is delivered in stages (randomly allocated) • Multiple data collection time-points • Intervention not withdrawn • Accounts for secular trends • Appropriate for community-level interventions	• Longer trial duration • Large amounts of data collection • Costly to implement • Caution must be taken to avoid contamination of control participants

2.1.1 Randomised controlled trials

The randomised controlled trial is the first study design to be discussed, because they are considered the most powerful design for evaluating interventions (Sibbald & Roland, 1998). In randomised controlled trials, eligible individuals are randomly assigned to either the intervention or control group. The control group does not receive the intervention, and are treated, as far as possible, as if the intervention did not exist, usually receiving existing services only. The main strength of randomised controlled trials is that the only

difference between the intervention and control group is the intervention. Any other differences between groups are due to chance, therefore, systematic differences can be ruled out (Sibbald & Roland, 1998).

Internal validity is extremely important in randomised controlled trials, referring to the extent to which differences identified between randomised groups are a result of the intervention being tested (Eldridge, Ashby, Bennett, Wakelin, & Feder, 2008). Internal validity depends on good study design, conduct, and analysis of the trial, with minimal bias (Altman et al., 2001). Poorly conducted randomised controlled trials are still susceptible to biases if; (a) some of the control group actually participate in the intervention, (b) being denied access to the intervention makes the control group act differently to how they would act in the total absence of the intervention, (c) the intervention group affect the behaviour or attitudes of those in the control group, and (d) the randomised controlled trial affects the way the intervention is implemented (Purdon, Lessof, Woodfield, & Bryson, 2001). Lack of consideration of external validity is the most frequent criticism of randomised controlled trials (Rothwell, 2005). External validity refers to the extent to which study results can be applied to other individuals or settings (Eldridge et al., 2008), and can be affected by the study's setting, participant characteristics, and differences between the study protocol and routine practice (Rothwell, 2005).

It is sometimes not possible to randomly allocate people in the same community to an intervention and control group. Examples include interventions that are delivered to whole communities, when intervention groups are initially formed on the basis of performance (e.g., high, medium, low), and that some variables (e.g., type 2 diabetes) just aren't experimentally induced. Randomised controlled trials are not often used in practice for evaluating community-level

interventions, because they are hard to reproduce in the real world, and tend to focus on individuals rather than communities (Sanson-Fisher et al., 2007). Doubts have been raised about whether subsequent scaling-up of individual interventions to larger populations, leads to changes in population prevalence (Sanson-Fisher et al., 2007). Additionally, when entire communities receive the intervention simultaneously, or it is deemed unethical to withhold the intervention from a proportion of the population, because there is a prior belief that the intervention will do more good than harm, randomised controlled trials may not be the most appropriate design for evaluating pragmatic community-level interventions (Sanson-Fisher et al., 2007). It is for these reasons that the randomised controlled trial was not selected as the study design of choice for evaluating the Devon Active Villages intervention. Therefore, less rigorous study designs, such as case studies, need to be considered as an alternative evaluation approach.

2.1.2 Case studies

Case studies address a different research question to the other designs mentioned above. However, case studies can be used to aid the understanding of community-level interventions, by examining individuals or organisations from the multiple perspectives of key actors (Purdon et al., 2001). They provide a detailed understanding of the experiences and outcomes in a specific case, where a case can be an individual participant, an area, or an organisation. Case studies typically comprise of qualitative research methods, such as in-depth interviews and group discussions. Strengths of case studies are that the data collected is normally a lot richer and of greater depth than can be generated through other research designs. Additionally, case studies can help

experimenters adapt ideas and produce novel hypotheses that can be used for later testing (Hodkinson & Hodkinson, 2001). The main limitation of case studies, however, is that it is very difficult to draw definite cause and effect conclusions from the data. Data collected often focuses on only one individual or organisation, meaning that selection bias is likely, and the ability to generalise to the wider population is limited (external validity; Hodkinson & Hodkinson, 2001). This leads to the data collected over longitudinal case studies not always being relevant or particularly useful. Case studies also tend to have only one experimenter collecting the data, leading to potential bias in the data collection (confirmation bias; Hodkinson & Hodkinson, 2001). Due to the design limitations mentioned above, case studies are often incorporated as a supplementary method for evaluating community-level interventions, rather than forming the main evaluation design. Therefore, case studies were not selected as the study design for the Devon Active Villages evaluation. A slightly more rigorous design that may be relevant to this particular study is an after-only design.

2.1.3 After-only designs

There are two types of after-only study designs: uncontrolled after-only and controlled after-only. Uncontrolled after-only designs only measure behaviours after the intervention's introduction to the community. A comparison community is not included in the study design. The benefit of this design is that it requires less data collection, therefore, it is associated with lower evaluation costs. The main limitation of this approach is that it is impossible to determine whether the measured behaviour would have been any different without the intervention (Institute for Work & Health, 2001). There is little evidence that the

observed effects are due to the intervention because there are no baseline measures to compare with (Kirk, 2012). Additionally, without a control population, the influence of secular trends or particular characteristics of the study population (selection bias) cannot be quantified (Kirk, 2012). The only acceptable use for this design is to ascertain if a certain standard has been met, therefore, it is not very useful for evaluating the effectiveness of community-level interventions (Institute for Work & Health, 2001).

Controlled after-only designs involve measuring behaviour in one community following the intervention, and also measuring behaviour in another community that did not receive the intervention, at the same point in time. If behavioural responses were favourable in the intervention community, it would be tempting to assume that the intervention was effective, however, it is impossible to know for sure, because baseline values for each community were not collected (Institute for Work & Health, 2001). Similar to uncontrolled after-only designs, no baseline measures means that secular trends cannot be accounted for. Because this design uses non-random samples, it cannot be assumed that the samples were equal at baseline (selection bias), additionally the researcher knows very little about the individual differences within the control group and how they may have affected outcomes (Kirk, 2012). Therefore, this design is also not useful for evaluating the effectiveness of community-level interventions, and thus, is not appropriate for the Devon Active Villages evaluation. One design that may be more useful for evaluating community-level interventions is an uncontrolled before-and-after study.

2.1.4 Uncontrolled before-and-after studies

In an uncontrolled before-and-after study, impact is estimated based on the difference between the outcomes measured on the eligible population both before an intervention is implemented, and after (Purdon et al., 2001). Baseline measurements act as the control measures in this design. The before and after measurements can either be taken on different cross-sections of the population or by taking repeated measurements on the same people (cohort samples). Cohort samples are useful for studying the effect of an intervention on individuals, but are less effective for measuring changes in the community, unlike repeated cross-sectional samples, which measure intervention effect at the population level (Caplan, Lane, & Grimson, 1995). Strengths of this design are that studies are relatively simple to conduct, are superior to observational studies, and it is possible to obtain a measure of intervention effectiveness (Grimshaw, Campbell, Eccles, & Steen, 2000). Uncontrolled before-and-after studies are particularly useful for demonstrating the immediate impacts of short-term interventions. This study design is less useful for evaluating longer term interventions, because longer time periods allows for more circumstances to arise that may obscure any intervention effects, threatening the internal validity of the study (Institute of Work & Health, 2001). The key limitation in this design is that any change brought about by the intervention cannot be separated out from the secular trends occurring in the communities throughout the intervention period. This is particularly problematic if the intervention is expected to have a relatively small impact (Purdon et al., 2001). Therefore, this study design is only recommended to use as a supplement to other more rigorous methods for evaluating community-level interventions, and thus, was not selected to evaluate the Devon Active Villages intervention. In order to strengthen the study

design it is possible to include control populations, for instance by using controlled before-and-after study designs.

2.1.5 Controlled before-and-after studies

In controlled before-and-after studies, observations are made before and after the implementation of an intervention, both in a group that receives the intervention and in a control group that does not. Control populations are usually selected for having similar characteristics and outcome levels to the intervention population, and are expected to experience secular trends or changes similar to the intervention population if the intervention was absent (Grimshaw et al., 2000). Outcomes are typically measured once before the intervention is implemented, and once after. However, the design is considerably strengthened if the number of measurement occasions is increased both before and after, and the intervention is followed up for several years (Purdon et al., 2001). Additional measurement periods provide more accurate estimations of secular trends, outcome behaviours (pre- and post-intervention), and intervention effects (e.g., immediate, delayed, sustained).

'Between group' analyses are used to compare performance in the intervention and control populations following the intervention, and any observed changes are assumed to be due to the intervention. It is often difficult, however, to identify a comparable control population (Grimshaw et al., 2000). If outcomes differ at baseline between the populations (selection bias), 'within group' analyses (where change from baseline is compared within both groups separately) are often undertaken. However, these analyses are limited because they do not adjust for the difference in baseline values, result in residual confounding, and do not allow for a direct comparison between intervention and

control groups (Grimshaw et al., 2000). The usefulness of controlled before-and-after studies is limited, because the estimate of effect cannot be attributed to the intervention with confidence if the control population is not randomly selected (Grimshaw et al., 2000). For community-level physical activity interventions, it is often not possible to randomise the intervention and control populations. In a review of community-wide physical activity interventions, Baker et al. (2011) reported that the majority of studies used a controlled before-and-after study design. Despite this study design having applicable strengths for evaluating community-level interventions, it was not selected as the study design of choice for the Devon Active Villages intervention because other study designs, such as interrupted time series designs, are available.

2.1.6 Interrupted time series designs

Interrupted time series designs attempt to detect whether an intervention has had an effect significantly greater than the underlying trend (Cook & Campbell, 1979). Data is collected at multiple time points both before and after the intervention. The underlying trend is estimated from the multiple time points before the intervention. The multiple time points after the intervention allow the intervention effect to be estimated, having adjusted for the underlying trend. This study design is useful for evaluating the effects of interventions when it is difficult to randomise or identify appropriate control populations (Grimshaw et al., 2000), for example, evaluating a national mass-media campaign, such as Change4Life. In order to generate a stable estimate of the underlying trend, and allow full time series modelling to be used, approximately 20 data points before and 20 data points after the intervention are required (Crabtree, Ray, Schmidt, O'Connor, & Schmidt, 1990). The large number of data collection time-points

can make this design difficult and costly to implement, unless routine data sources are available. Disentangling potential intervention effects can be difficult, because this study design does not protect against the effects of other events occurring at the same time as the study intervention (Grimshaw et al., 2000). It is possible for interrupted time series designs to incorporate a control population into the study design, however, this would not be possible for evaluations of national interventions, and would considerably add to the cost of the study. Because of the costs associated with conducting an interrupted time series design, it was not selected as the study design for the Devon Active Villages evaluation. Instead, more cost-effective study designs, such as cluster randomised controlled trials, may be more appropriate for this particular study.

2.1.7 Cluster randomised controlled trials

It has been suggested that the most appropriate design for evaluating community-level interventions that are by necessity delivered to groups rather than individuals, are cluster randomised trials, which randomise groups of individuals (e.g., communities, villages, towns) and measure outcomes on individual participants within those groups (Craig et al., 2008; House of Lords, 2011). Cluster randomised trials commonly use a parallel group design, in which the clusters are randomised to either the intervention or control arm of the study at the same time. Randomising clusters, rather than individuals within areas, minimises treatment “contamination” between intervention and control participants, due to controls being less likely to learn about the intervention if it is being delivered in an area separate to their own (Grimshaw et al., 2000; Torgerson, 2001). Randomised controlled trials assume that study individuals are completely independent of each other, however, cluster randomised

controlled trials violate this assumption, because individuals within a cluster are more likely to respond in a similar manner (Grimshaw et al., 2000). Cluster randomised controlled trials require larger sample sizes to allow for the effect of the cluster (Rice & Leyland, 1996; Bland, 2000). Many studies rule out cluster randomised controlled trials, because of the large number of clusters that need to be recruited (Purdon et al., 2001), and for practical reasons it may not be possible to deliver an intervention to many clusters at the same time. If there is a prior belief that the intervention will do more good than harm, it may be unethical to withhold the intervention from a proportion of participants (Brown & Lilford, 2006; Hussey & Hughes, 2007). In situations like these (e.g., evaluations of disease vaccination interventions), alternative study designs, such as stepped wedge cluster randomised controlled trials, are desirable.

2.1.8 Stepped wedge cluster randomised controlled trials

As an alternative to the parallel groups design, stepped wedge cluster randomised controlled trial designs involve interventions being delivered sequentially to all trial clusters over a number of time periods (Cook & Campbell, 1979). Clusters effectively cross over from the control to the intervention group, and the stage at which the clusters cross over is randomly allocated (Hussey & Hughes, 2007). Outcomes are measured on the study participants in all clusters at every time period so that each cluster provides data points in both the control and intervention conditions (Brown & Lilford, 2006). Examples of stepped wedge investigations include the efficacy of Hepatitis B vaccinations (Gambia Hepatitis Study Group, 1987), the effect of housing improvements on respiratory health symptoms (Somerville et al., 2002),

and different tuberculosis treatments on number of disease episodes (Grant et al., 2005).

One example of an evaluation study that used a stepped wedge cluster randomised controlled trial design investigated the effects of introducing a critical care outreach service on in-hospital mortality and length of stay (Priestly et al., 2004). The intervention was sequentially introduced to 16 adult wards in a general hospital in Northern England, and all admissions to the wards during a 32-week study period were included (*n* = 2903). Priestly et al. (2004) found that the outreach intervention reduced in-hospital mortality compared with control (two-level odds ratio: 0.52; 95% CI: 0.32-0.85). However, compared with control, the outreach intervention increased patients' mean length of stay (hazard ratio: 0.90; 95% CI: 0.84-0.97), but confirmatory and sensitivity analyses did not fully support this. To date, as far as I am aware, no studies have used the stepped wedge cluster randomised controlled trial design to evaluate a community-level physical activity intervention.

Advantages of the stepped wedge cluster randomised controlled trial design are that all clusters will eventually receive the intervention, that it can be delivered in stages, and that once delivered it is not withdrawn, as would occur in a cross-over design (Hussey & Hughes, 2007). The disadvantages of the stepped wedge design are that it can lead to a longer trial duration than traditional parallel designs, large amounts of data collection are required, so they can be costly to implement, and caution must be taken to prevent contamination between intervention participants and those waiting for the intervention (Brown & Lilford, 2006). However, with careful planning and monitoring, the stepped wedge design can be an effective way of ensuring a robust evaluation is undertaken (Brown & Lilford, 2006). Therefore, the stepped

wedge cluster randomised controlled trial was selected as the most applicable study design for the Devon Active Villages intervention evaluation.

2.1.9 Conclusions

Despite many study designs being available, each with different strengths and limitations, some designs are more suitable for evaluating community-level physical activity interventions than others. When choosing a study design, it is important to consider both the research question being addressed, and the resources available for conducting the study (e.g., funding, researcher time). It is always best to select the most rigorous study design available, which fits with the community-level intervention being evaluated and the research budget.

Randomised controlled trials are generally not suitable for evaluating community-level interventions, because they tend to focus on individuals, and are not always reproducible in the real world. Case studies are also not suitable for evaluating community-level interventions, because they address a different research question, and can only help improve the understanding of an intervention's effect on an individual or organization. After-only designs and uncontrolled before-and-after designs cannot definitively determine causality, because they are unable to separate intervention effects from the effects of secular trends. Interrupted time series designs can adjust for the effect of secular trends, if enough data collection time points occur before and after the intervention, however, they cannot protect against the effect of other events occurring at the same time. Controlled before-and-after designs are commonly selected designs for evaluating community-level physical activity interventions, because they are relatively easy to conduct. However, if the intervention and

control populations are not randomly selected, it is not possible to be confident about estimates of effect sizes. Cluster randomised controlled trials, in the form of a parallel groups design, are suitable designs for rigorously evaluating community-level interventions. However, this design may not be feasible for all studies if the intervention needs to be delivered to many clusters at the same time. Therefore, alternative study designs, such as the stepped wedge cluster randomised controlled trial, may be more appropriate, because the intervention is delivered sequentially to all clusters over a number of time periods. It is for these reasons that the stepped wedge study design was selected to evaluate the Devon Active Villages intervention.

2.2 Physical activity measurement techniques

Techniques for measuring physical activity have evolved considerably over the years, producing stronger evidence that physical activity improves health (Zhang, Werner, Sun, Pi-Sunyer, & Boozer, 2003). Developing accurate, valid, and cost-effective techniques to quantify physical activity under free-living conditions is the greatest challenge (Paffenbarger, Blair, Lee, & Hyde, 1993). Precise methods of measuring physical activity are needed in order to quantify dose-response relationships, gene-environment interactions, longitudinal changes in activity patterns, and evaluate intervention effectiveness.

Numerous methods have been used to measure physical activity, varying greatly in their applicability, ease of assessment and precision (Zhang et al., 2003; Figure 2-2). The simplest, but least precise, methods are self-report measures, for example questionnaires and activity diaries (or logs). Self-report measures are the most convenient and cheapest way to collect physical activity data from a large number of people in a short time. More difficult to assess, but

also more precise, are objective measures, including pedometry, accelerometry, heart rate monitors, and combination heart sensors. Valid objective methods are now available for use in relatively large-scale epidemiological studies (*n* ~5000). Finally, the most precise, but also the most difficult to assess, are criterion methods, such as indirect calorimetry and doubly labelled water. All of the available methods are associated with various pros and cons (Table 2-3). Unfortunately, no method currently exists that measures all dimensions of physical activity (frequency, intensity, duration, type), in all domains (leisure-time, work, household, transport). Therefore, choosing a suitable method is a trade off between the aspect of physical activity that is central to the research question being addressed, the available resources, and the feasibility of the preferred method (Zhang et al., 2003). To obtain the desired outcomes, a combination of methods may be required.

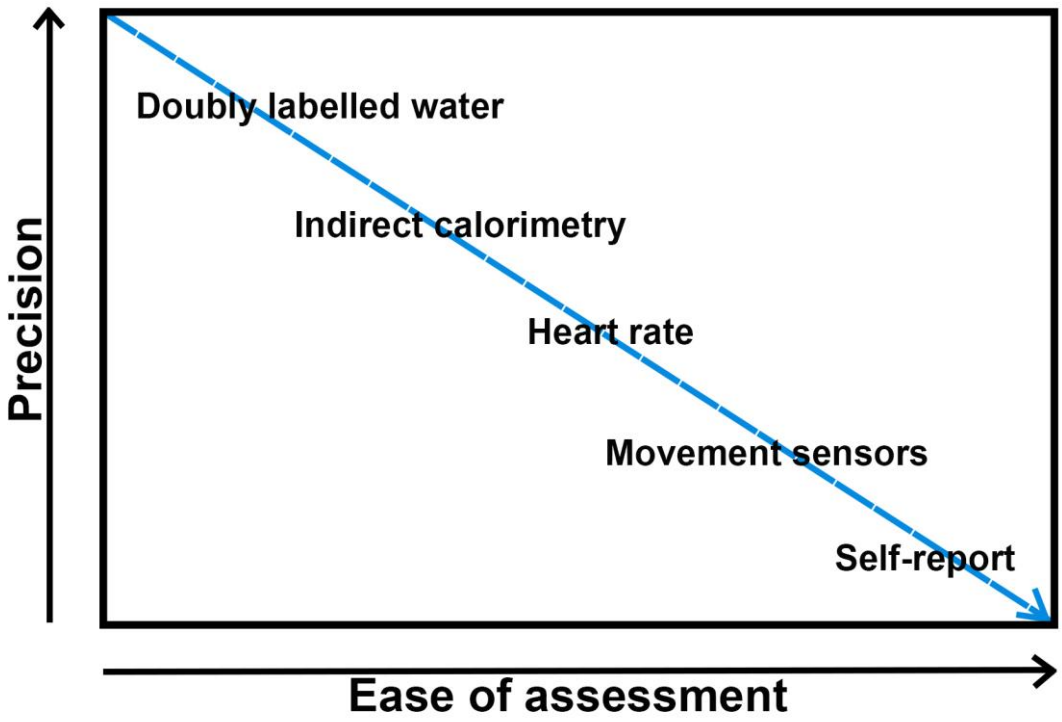


Figure 2-2 Levels of sophistication for physical activity measurements (Ekelund, 2004)

2.2.1 Other sensors

With advances in technology, a number of sensors have been adapted for use in assessing physical activity behaviour, despite being originally designed for alternative uses. Two such sensors are wearable cameras (SenseCam) and global positioning systems (GPS). SenseCam is a wearable camera that takes photos automatically, and was originally conceived as a personal ‘Black Box’ accident recorder, and later used as a recall device. SenseCam can be used to measure multiple behaviours and contexts at once, can aid recall of behaviours, and provide images that may motivate change. Doherty et al. (2012) found that wearable cameras can provide data for objective categorisation of accelerometer-defined episodes of activity in free-living situations. GPS is a space-based satellite navigation system that provides location and time information. For the measurement of physical activity behaviour, GPS can help distinguish between transport modes and provide activity location information. GPS has been found to be a useful tool to understand physical activity behaviour by providing the context of the activity and can provide insight into how people interact with the environment, however, GPS devices are most reliable and valid when used in combination with other activity sensors (Maddison and Ni Mhurchu, 2009).

Table 2-3 Pros and cons of physical activity measurement methods

Method	Pros	Cons
Questionnaire	• Suitable for most populations • Low respondent burden • Relative ease of data collection and analysis • Relatively convenient • Suitable for large scale studies • Single instrument assesses a variety of variables • Assesses activity domain relevant to research question • May provide details of the location and types of activity	• Subject to recall bias • Subject to social desirability bias • Many questionnaires not suitable for children or elderly • Unable to estimate energy expenditure • Should be adapted and modified to make them suitable for the population under study • Modified questionnaires require testing for reliability and validity
Activity diary (or log)	• Provide detailed and comprehensive information • Bouts of physical activity can be quantified • Patterns of activity can be identified • Prospective – does not rely on recall or memory • Best subjective method to estimate energy expenditure • Inexpensive to administer	• Considerable respondent burden • Unsuitable for younger children • Data processing is complex and time consuming • Undertaking diary (or log) may influence behaviour • Respondents may not complete diary (or log) prospectively • Not as accurate as objective measures
Pedometry	• Suitable for all populations • Low participant burden • Ease of data collection and analysis • Generally cheap • Suitable for large scale studies • Quality models provide valid and reliable measure of steps taken • Can be used a motivational tool	• Behaviour may alter in response to readings • Some subjects may tamper with the monitor • Can register 'false' activity (e.g., travelling in a car) • Not possible to assess intensity, frequency, or duration of activity • Not accurate for assessing energy expenditure • Some pedometers reliant on user logging daily step readings, therefore, susceptible to recall bias
Accelerometry	• Objective measure of total PA • Gives detailed description of activity patterns • Devices have reasonable data storage capacity • Method is extensively validated • High validity compared to indirect calorimetry (r=0.8-0.9) • Able to detect change in activity	• Single-mounted accelerometer unable to measure all activity • Amount of data produced requires skill to process and interpret • Large number of prediction equations available confuses

Table 2-3 (continued)

Method	Pros	Cons
Accelerometry	• Unlikely to influence behaviour due to process of measurement • Relatively cheap compared to combined sensors • Low participant burden • Suitable for all populations	energy expenditure estimations • Compliance may differ according to where accelerometer is attached • Data collection can be expensive and labour-intensive
Heart rate monitoring	• Suitable for most populations • Low participant burden for short wearing times • Easy and quick for data collection and analysis • Non-wearing time easily identified • Waterproof • Relatively cheap • Physical activity may be measured at group level • Linear relationship between heart rate and energy expenditure at high activity levels	• Relationship between heart rate and energy expenditure at low activity levels is not strong • Degree of individual calibration is required • Other factors affect HR (temperature, caffeine, beta blockers, anxiety) • Participant burden increases over longer periods • Method may be problematic with young children • Chest straps may cause discomfort • Not always easy to pick up heart rate
Combination heart sensors	• Objective measure of total PA • Accurate estimate of energy expenditure during PA • Measure shown to be reliable and valid • Gives detailed description of activity patterns • Storage capacity of 7+ days • Unlikely to influence behaviour • Single-piece devices involve reasonably low participant burden • Suitable for most populations • Easy and quick for data collection and analysis • Non wearing time easily identified • Waterproof • Reasonably low level calibration required • Combined approach overcomes many of the drawbacks from methods used in isolation	• Devices are expensive • Data produced is complex, and requires careful interpretation and guidance from experienced others • Separate devices impose a reasonable individual burden • Compliance may be difficult in some populations • Electrodes (if used) may cause adverse skin reaction

Table 2-3 (continued)

Method	Pros	Cons
Indirect calorimetry	• Accurate and reliable measure of energy expenditure • Suitable as a criterion validation method for objective measures of physical activity • More portable systems can be used in the laboratory and in field situation, although only for relatively short time periods	• Even the portable equipment is unsuitable for long-term use in free-living conditions • Expensive • High respondent burden, especially for longer term assessment
Doubly labelled water	• Gold standard method for measuring energy expenditure in free-living subjects • Does not interfere in participant's daily activity • Provides criterion validity for estimates of total energy expenditure and reported energy intake	• Expensive • Mass spectrometry is also expensive • Does not give a direct measure of energy expended in physical activity • No indication of the intensity, frequency, duration, or domain of physical activity

Information sourced from: www.dapa-toolkit.mrc.ac.uk/physical-activity-assessment/ (UK Medical Research Council, 2013).

2.2.2 Questionnaires

Physical activity questionnaires are the most widely used self-report instrument to assess physical activity. Questionnaires can be either self-completed (postal or internet survey), or interviewer-administered (face-to-face or telephone interview; Matthews, 2002). There is an abundance of physical activity questionnaires available, varying greatly in detail, and many have been comprehensively tested for reliability and validity (Pereira et al., 1997). Questionnaires either aim to stratify the population into broad categories of physical activity (recall questionnaires), or to capture information in various domains according to several dimensions of physical activity (quantitative history questionnaires). Examples of recall questionnaires include the short version of the International Physical Activity Questionnaire (IPAQ) and the

Baecke questionnaire. The long version of the IPAQ and the Modifiable Activity Questionnaire are examples of quantitative history questionnaires.

Questionnaires can provide information on the domain and mode of physical activity, which cannot be obtained via objective measures (i.e., accelerometry). However, many questionnaires focus primarily on leisure-time physical activity and exclude other domains, therefore, they do not provide a measure of habitual activity (Wareham, 2007). Some questionnaires attempt to estimate physical activity energy expenditure, by using the Compendium of Physical Activity (Ainsworth, Haskell, Whitt, Irwin, & Swartz, 2000), which classifies specific activities by rate of energy expenditure and defines the ratio of work metabolic rate to a standard metabolic rate (MET). However, most questionnaires are unable to do this with accuracy (MacFarlane, Lee, Ho, Chan, & Chan, 2006). Studies that use interviewer-administered questionnaires must ensure rigorous training has been done with all interviewers, to ensure a standardised approach is taken. Physical activity questionnaires are subject to bias as a result of the cognitive demands of the recall process (Cauley, LaPorte, Sandler, Schramm, & Kriska, 1987). Thus, self-report questionnaires are not always suitable for young children, due to cognitive immaturity (Sallis, 1991), or the elderly, due to cognitive degeneration (Washburn, 2000). Special questionnaires have been developed specifically to suit certain populations, such as the Children Physical Activity Questionnaire (CPAQ), and the Physical Activity Survey for the Elderly. Self-report questionnaires are also culturally dependent, where validity results assessed in one population may not be directly applicable to other populations, ethnic groups, or other geographic regions.

Problems with reliability, validity, and sensitivity are common in questionnaire studies (Shephard, 2003). If questionnaires are poorly constructed and inadequately piloted they will be badly completed and provide data of limited quality, therefore, questionnaires need to be well formatted and clearly structured to guide the participant. If researchers intend to use questionnaires to measure physical activity, they must be clear on the primary outcome of the questionnaire (e.g., activity dimensions and domains the questionnaire is designed to measure), and ensure this fits with the research question being addressed. Questionnaires are appropriate methods for evaluating community-level interventions because they are easy to conduct with large samples, collect lots of participant information with limited burden to the respondent, and do not require participants to visit a test centre, therefore, they tend to result in greater compliance.

2.2.3 Activity diaries (or logs)

Physical activity diaries (or logs) provide a detailed record of an individual's daily physical activity. In physical activity diaries, individuals are instructed to record individual bouts of activity from a pre-defined list (Compendium of Physical Activity; Ainsworth et al., 2000), as they occur during the day. In contrast, logs instruct individuals to record the time spent in broad categories of activity (e.g., inactive, sitting, light, moderate, vigorous). Records are generally completed prospectively, as the activities are completed, with each 24-hour period typically broken down into 15-minute segments.

For studies that require detailed information on physical activity (i.e., frequency, duration, and intensity) across all domains (i.e., household, transport, work, and leisure), physical activity diaries and logs are particularly useful.

Diaries and logs have been used mainly in small to medium sized studies (i.e., less than 500 people), because they are time-consuming and complex to analyse so may not be appropriate for larger studies. Because these methods impose a significant response burden, they are not suitable for young children (i.e., under 10 years). Diaries are more burdensome for participants to complete, and the data are more complex to enter and analyse, however, they do produce more detailed information (i.e., types of activity, intensity and patterns) than logs. Because of the effort required for participants to complete physical activity diaries or logs, measurement periods are typically limited to between 1 and 7 days, therefore, consideration must be made for the possible differences between weekday and weekend activity (Baranowski & de Moor, 2000). One concern is that keeping a diary or log book of activity may cause individuals to change (increase) their physical activity (i.e., a reactivity effect). Activity diaries have been found to produce more accurate estimations of energy expenditure, compared to recall questionnaires, but less accurate estimations compared to objective measures (Irwin, Ainsworth, & Conway, 2001). Diaries and logs are also suitable for measuring adherence to recommended physical activity guidelines. Activity diaries (or logs) may be suitable for relatively small evaluations of community-level interventions (<500 participants), however, not for larger studies where questionnaire page space and researcher time is at a premium.

2.2.4 Pedometry

Pedometers are low-cost motion sensors, typically worn on a belt or waistband, which respond to vertical accelerations of the hip during gait cycles (Welk et al., 2000). Because pedometers provide data on steps taken, they only

really measure walking activity, and cannot capture activities such as swimming, cycling, hill walking, or weight lifting. Fortunately walking is one the most common forms of physical activity (Townsend et al., 2012). Using pedometers, individuals are classified as ‘active’ if they achieve at least 10,000 steps per day (Tudor-Locke & Bassett, 2004). Limited research evidence exists supporting the 10,000 steps recommendation (Welk et al., 2000), however, it is generally accepted as a reasonable activity goal. Pedometers have become increasingly popular in recent years, and used in a variety of settings (e.g., clinical studies, cross-study comparisons of different populations, and evaluations of community-level interventions). They have also been used as incentives to increase physical activity in community-level interventions, for example in the ‘10,000 Steps Rockhampton’ intervention (Brown et al., 2006).

There is a wide range of pedometers available, with varying degrees of accuracy, usually reflected in their cost (Tudor-Locke et al., 2006). Schneider, Crouter, Lukajic, and Bassett (2003) compared recorded steps with actual steps, finding eight out of ten electronic pedometers were considered ‘accurate’. However, comparing pedometers over fixed distances or at a variety of treadmill speeds is not reflexive of their performance in free-living conditions, therefore, guidelines have been produced to assess the suitability of pedometers for research studies (Tudor-Locke et al., 2006). In a systematic review assessing the validity of different physical activity measurement techniques, pedometers were found to be a valid method of assessing physical activity when compared to different accelerometers (r = 0.86; Tudor-Locke, Williams, Reis, & Pluto, 2002).

Pedometers are feasible for large-scale studies (i.e., more than 1000 subjects), as well as surveillance studies and international comparisons due to

their low cost. The main limitation of pedometers is that they are not sensitive to gait differences, such as stride length, which vary significantly among activities, and from person to person (Zhang et al., 2003). However, some pedometer models do allow for a low level of individual calibration. Simply wearing a pedometer is associated with significant increases in physical activity, especially if step counts are visible (Bravata et al., 2007).

It is clear that pedometers can be a suitable method of assessing physical activity behaviour during community-level interventions, especially if interventions are focused around promoting walking behaviour. However, if the intervention being studied promotes activities other than walking, it may not be the most appropriate measurement tool to suit the research question. Pedometers fail to provide much information on the different dimensions and domains of physical activity, as well as participant characteristics and measures of intervention awareness. Therefore, combining pedometer data with questionnaire measures might be more useful for evaluations of community-level interventions.

2.2.5 Accelerometry

Accelerometry is the most common objective method used to measure physical activity, used extensively in field settings to monitor activity patterns. Accelerometers are most commonly worn on the hip or lower back, which allows for movement to be tracked at the trunk, the largest and most central part of the body (Trost, Mciver, & Pate, 2005). Accelerometers directly measure acceleration, the change in velocity with respect to time, of the body or segments of the body. Acceleration is measured by piezoelectric or seismic sensors in one (vertical), two (vertical and medio-lateral), and three (vertical,

medio-lateral and anterior-posterior) directions (Chen & Bassett, 2005). While body acceleration is the primary outcome measure, secondary measures include estimates of bout frequency, duration, and intensity of body movement. Energy prediction equations and cut-points to differentiate thresholds of activity intensities are used to characterise the relationship of movement counts and other physiological measures of activity.

Collecting physical activity data in real time is an important advantage of accelerometry, compared to self-report methods. Initially, accelerometers were used as an outcome measure in small studies and a criterion method to compare self-report data. However, as accelerometers have advanced, and become cheaper, they have increasingly been used in large studies with thousands of participants, for example evaluations of community-level physical activity interventions (e.g., the 'Women of Color: Health is Power' intervention; Lee et al., 2012b) and in sub-samples of national health surveys (e.g., Health Survey for England 2008; Craig et al., 2009). Advances in technology have led to the development of devices that are small and discrete for participants to wear, and can measure activity accurately over extended time periods (>7 days).

Accelerometers have been extensively validated (Brage, Wedderkopp, Franks, Andersen, & Froberg, 2003; Rothney, Apker, Song, & Chen, 2008). However, studies have shown differences in values both within and between accelerometer models (Welk et al., 2000). Acceleration is often expressed as a count value, however, a count is an arbitrary unit, which varies across devices and even generations of the same device type (Rothney et al., 2008). Some studies have experimented with using multiple monitors, in order to get a more detailed picture of physical activity behaviour. However, despite multiple

monitors producing marginal improvements in the estimation of energy expenditure, any effects are negated by the increased participant burden (i.e., anticipated reduction in compliance), and the increased time needed for data analysis (Swartz et al., 2000).

Accelerometers produce somewhat lengthy, detailed, and complex data compared to questionnaires, which increases the burden on the researcher. Because most models are not waterproof, accelerometers are usually not suitable for swimming or other water-based activities. Additionally, accelerometers attached to the waist underestimate carrying heavy loads or walking on an incline, and fail to capture cycling or upper body movements. Therefore, accelerometry would not be suitable for evaluating community-level interventions that focus on promoting activities such as cycling. Accelerometers only detect the moving or shaking of the sensor, they are not “smart” enough to know what type of physical activity is being performed (Zhang et al., 2003). In order to gain an accurate picture of physical activity, and identify reasons for non-wearing of the accelerometer, it may be useful to ask participants to complete an activity log concurrently.

It is clear that accelerometers can be suitable for assessing physical activity in evaluations of community-level interventions. Although, accelerometers produce accurate estimations of energy expenditure, they are still quite expensive to use in large evaluation studies, and require lots of researcher time. Therefore, accelerometers may not be suitable for evaluations being conducted on a tight budget.

2.2.6 Heart rate monitoring

Heart rate monitoring is a measure of a direct physiological response to physical activity. In steady state exercise involving large muscle groups a linear relationship exists between heart rate and energy expenditure. This linear relationship varies within and between individuals (Li, Deurenberg, & Hautvast, 1993), and is affected by many factors including age, gender, weight, fitness levels, ambient temperature, body posture, anxiety, and stress (Dugas, Van der Merwe, Odendaal, Noakes, & Lambert, 2005). Heart rate monitors typically take the form of a chest strap that is wirelessly connected to a data logger hidden in a watch. Alternatively, electrodes can be used to obtain heart rate. From the raw heart rate data researchers identify the time spent at different intensity levels using absolute heart rate values (Sirard & Pate, 2001) or heart rate indices (Trost, 2001). Alternatively, physical activity energy expenditure is estimated using regression equations derived from individual or group calibrations.

Heart rate monitoring has been shown to have high reproducibility within subjects (Strath et al., 2000). As well as estimating energy expenditure, heart rate monitors can provide an indicator of frequency and duration of physical activities. Newer heart rate monitors allow for minute-by-minute data collection, with multiple days' storage capacity, without displaying heart rate, improving the feasibility of this objective measure of physical activity. The linear relationship between heart rate and physical activity is reliable during higher intensities of activity, but is not reliable at lower intensities, making the assessment of heart rate data quite problematic. Additionally, if the heart rate display is visible to participants this can influence physical activity, especially at day one of testing. Heart rate monitoring may not be suitable for use in young children, because

heart rate response tends to lag after changes in movement, and remain elevated after movement stops, possibly masking sporadic activity patterns common in children due to “play” (Trost, 2007). To increase the accuracy, and overcome the limitations of heart rate monitoring, a number of techniques have been developed including individual calibration (Rennie, Hennings, Mitchell, & Wareham, 2001), and heart rate indices (Trost, 2001).

Heart rate monitoring places considerable burden on both researchers and participants, from the individual calibration testing through to the analyses of the heart rate data to derive energy expenditure estimates. Due to this, heart rate monitoring is only suitable for relatively small epidemiological studies (up to 800 individuals; Rennie et al., 2001). To reduce researcher and participant burden, studies can use prediction equations (rather than individual calibration), supplemented by information from a short questionnaire, to estimate energy expenditure, which would help make this measure more feasible for use in evaluations of community-level physical activity interventions.

2.2.7 Combination heart sensors

Combining heart rate monitors with motion sensors to measure physical activity is a developing area of research. Over twenty years ago, the first study to combine heart rate monitoring with movement registration demonstrated improved estimates of energy expenditure (Avons, Gartwaite, Davies, Murgatroyd, & James, 1988). Since then, a number of studies have found that combined measures increase the accuracy to predict physical activity energy expenditure, compared to each of the measures in isolation (Haskell, Yee, Evans, & Irby, 1993; Rennie, Rowsell, Jebb, Holburn, & Wareham, 2000; Strath, Bassett, Thompson, & Swartz, 2002). Combined measures are suitable for

estimating physical activity energy expenditure for both adults and children. However, as for heart rate monitoring, combined sensors produce complex data, and require either individual calibration or equation modelling.

Combining heart rate monitors and motion sensors negates some of the disadvantages of using each method alone, through utilising the unique advantages of each method (Brage et al., 2004). For instance, heart rate monitoring is less accurate at estimating energy expenditure at lower intensity levels, but this is the level where accelerometer models have low error, and vice versa for high intensity levels. Additionally, heart rate monitors can capture activities that are not measured well by accelerometers (e.g., cycling, hill walking, upper body weight lifting), and the two measures combined can more easily determine periods of non-wearing (Brage, Brage, Franks, Ekelund, & Wareham, 2005).

Single-piece combined sensors are now available; the first to be commercially available was the Actiheart sensor (Brage et al., 2005). The Actiheart sensor is small (7mm thick with 33mm diameter), weighs only 8 grams, does not require a chest strap (i.e., uses electrodes instead), is waterproof, allows for eleven days of continuous monitoring, and provides advanced analyses to estimate energy expenditure more accurately. This heart rate and motion sensor has been rigorously tested for intra- and inter-instrument reliability and validity (Brage et al., 2005).

Combined sensors provide detailed information on activity frequency, intensity, and duration, and aside from doubly labelled water and indirect calorimetry it is one of the most accurate methods for estimating physical activity energy expenditure over longer durations. Therefore, combined sensors are appropriate for cross-sectional studies investigating physical activity,

prospective cohort studies investigating links with disease, and evaluations of physical activity interventions. However, such devices are still relatively expensive, and although some relatively large-scale population based studies (> 5,000 participants) have used them, the cost would not be feasible for many studies. It is anticipated that combined devices will become cheaper in the future, and, therefore, become more feasible for large-scale evaluations of community-level physical activity interventions.

2.2.8 Indirect calorimetry

Indirect calorimetry is a technique that provides accurate estimates of energy expenditure, from measures of carbon dioxide production and oxygen consumption during rest and steady-state exercise. The ratio of carbon dioxide produced to oxygen consumed (i.e., VCO_2/VO_2) is known as the respiratory exchange ratio, and will determine the kilojoule or kilocalorie equivalent value for each litre of oxygen consumed. The experimental protocol used determines which components of energy expenditure are captured. Basal metabolic rate is the largest component of total energy expenditure typically 60-75% when measured over 24 hours, with the thermic effect of food the smallest component at 10%. The remaining component of total energy expenditure is physical activity energy expenditure, which is the most variable between individuals but typically constitutes 15-30%. There are open- and closed-circuit methods, and technology has advanced from the Douglas bag method to fully-portable, electronic equipment that provides continual and instantaneous breath-by-breath values of pulmonary gas exchange.

Indirect calorimetry is suitable for the validation of objective measures of physical activity (i.e., accelerometers and heart rate monitors). However, this

method is not suitable for validating self-report measures such as questionnaires, that measure habitual activity. Despite this method providing accurate estimations of energy expenditure, personal details (i.e., age, gender, height, weight, and body composition) may be needed to better interpret data. Portable devices are generally less accurate compared to stationary devices. Continuous gas exchange measures are normally limited to collecting data over 1-5 hours; therefore, this method is not suitable for measuring physical activity over several days. Indirect calorimetry puts a high burden on the researcher, because it is conducted on an individual basis, the system needs calibrating prior to use, and specialist training is required to verify that the system is in good working order. Because indirect calorimetry is a time-consuming and expensive process, it is only really suitable for smaller studies, and not very suitable for large-scale evaluations of community-level physical activity interventions.

2.2.9 Doubly labelled water

Doubly labelled water (Lifson, Gordon, & McClintock, 1955) measures total energy expenditure by observing the differential rates of elimination of a bolus dose of the stable isotope tracers ^{2}H (deuterium) and ^{18}O. Study participants are asked to drink a known dose of water enriched in ^{2}H and ^{18}O, following this samples of blood, saliva, or urine are collected over the next 5-14 days, from which the isotopic composition of the body water can be determined. This method has been used in many diverse investigations, including the energy costs of clinical conditions, the energy utilisation of individuals participating in intensive physical activities under extreme conditions, and as a criterion validation tool for other methods of assessment of diet and physical

activity (e.g., questionnaires, diaries, logs, and accelerometers). Doubly labelled water assessment is also often undertaken in large-scale national surveys, with a representative subsample of subjects.

Combining doubly labelled water and indirect calorimetry provides a robust method of measuring the energy expenditure due to physical activity. The tracers are completely safe to use in any population (adults and children), because they occur naturally in water, and are non-radioactive. However, this method requires experience in the area, and rigorous attention to detail at every stage. Although the cost of isotopes has fallen in recent years, making this method more accessible, it is still a very expensive measurement for research, and, therefore, can only be undertaken in small numbers of subjects (i.e., less than 100 participants). Because of the difficulties mentioned above, this method is not suitable for evaluating community-level physical activity interventions.

2.2.10 Conclusions

It is clear that there is a wide range of physical activity measurement techniques on offer, each differing in terms of accuracy, reliability, ease of assessment, cost, and feasibility. The varying strengths and limitations of each measure make them more, or less, suitable for use in studies of different types (e.g., validation studies, prospective cohort studies, intervention evaluation studies), and sizes (<100 participants to >10,000 participants).

Doubly labelled water and indirect calorimetry are criterion methods, which are expensive, complicated to conduct, and are most suited for small validation studies with less than 100 participants. Therefore, these criterion methods are not suitable for large-scale evaluations of community-level physical activity interventions. Thus, it is self-report and objective measures that are

most suitable for evaluating community-level physical activity interventions. Self-report measures of physical activity are generally cheaper, easier to assess, and easier to conduct in larger studies, compared to objective measures. However, self-report measures are associated with bias due to social desirability, and may lead to some misclassification due to recall difficulties. Nevertheless, in intervention evaluation studies, there is usually no reason to believe that any misclassification would be systematically different with regard to the intervention or control group. Objective measures can more accurately estimate physical activity energy expenditure, compared to self-report measures. However, objective measures are associated with increased researcher and participant burden, and considerably greater cost. Therefore, when conducting an evaluation of a community-level physical activity intervention, it is important to weigh-up the resources available for conducting the research (e.g., funding, equipment, and researcher time), with the requirement for accuracy in the estimates of physical activity behaviour.

2.3 Differences between rural and urban physical activity

There is no single definition of a rural area, because there are many approaches to classifying what is ‘rural’, including population, population density, land use, and socio-economic characteristics. Populations are generally classified as urban if the bulk of a population falls in a settlement of greater than 10,000 residents (Office for National Statistics, 2001). The majority of physical activity studies to date have examined urban populations (Yousefian et al., 2010). Although 20% of the population live in non-urban dwellings (Craig et al., 2009), rural populations are generally understudied (Barnidge et al., 2013; Ogilvie et al., 2010; Saelens et al., 2002). Despite there being great

reason to believe that creating infrastructures to make healthy choices possible is likely to make a difference in rural areas, much of the evidence to date on environmental and policy change related to physical activity and healthy eating comes from urban and suburban areas (Frost et al., 2010). As a result of this shortage of evidence, interventions tested in suburban or urban areas, are often made to fit rural areas (Bellamy, Bolin, & Gamm, 2011).

When examining the influence of residential location on physical activity, most studies have found that rural adults are less likely to meet recommended physical activity guidelines than urban adults, making rural residents appropriate targets for future physical activity interventions (Bertrais et al., 2004; Brownson et al., 2000a; Martin et al., 2005; Parks, Housemann, & Brownson, 2003; Wilcox, Castro, King, Housemann, & Brownson, 2000). In England, both urban and rural dwellings report similarly low levels of physical activity in adults: on average, 9.5 days per month (95% CI: 9.3-9.6) of moderate-to-vigorous intensity physical activity for at least 30 minutes (Craig et al., 2009). Rural residents are also more likely to be overweight or obese than their urban counterparts (Jackson, Doescher, Jerant, & Hart, 2005).

Several studies have highlighted differences between urban and rural adults. For instance, Parks et al. (2003) found noticeable differences in the importance of places to exercise on physical activity behaviour. Access to parks, walking trails, and exercise equipment was found to be important for urban adults, while access to neighbourhood streets for activity, and an indoor gym were more important for rural adults (Parks et al., 2003). Younger age, fewer barriers to leisure time activity, and social support have been reported as correlates of physical activity in urban women, compared to higher educational attainment, and the presence of enjoyable scenery for rural women (Wilcox et

al., 2000). Residents of rural areas are also more likely than their urban/suburban counterparts to report lower social support, limited access to exercise facilities, and fewer pavements as barriers to being physically active (Murimi & Harpel, 2010; Parks et al., 2003; Wilcox et al., 2000). Eyler (2003) found that the most frequently reported barrier to being physically active among rural women was the remoteness and how rural the local area was, although neither of these factors were associated with reported activity. Previous research has indicated that being too far from activity facilities is a major barrier for women living in rural areas (Brownson et al., 2000b; Eyler et al., 2000). The small population sizes that define rural communities, present unique challenges to the planning, implementation, and evaluation of environmental and policy change intervention (Barnidge et al., 2013). Small population sizes are associated with a number of barriers to physical activity, including limited interest by funders, human capital (limited staff availability), and low priority placed on physical activity (Barnidge et al., 2013). One study also found that rural residents have limited exposure to preventive health care messages (Murimi & Harpel, 2010).

One recommendation for public health practitioners when designing interventions for small populations with limited resources, is to capitalise on regional resources, through sharing resources and training opportunities (Barnidge et al., 2013). This will enhance the capacity of smaller communities to participate in these types of interventions. However, it is important to acknowledge the diversity of various rural populations within a geographic region, therefore, one intervention may not fit all communities (Barnidge et al., 2013).

Most studies that have focused on rural areas have examined communities from the United States, where it is often the case that rural dwellers are of lower socioeconomic status than urban residents (Singh, 2003), which may explain some of the differences in physical activity behaviour compared to urban areas. Generally in England, however, people living in rural areas are often among the most affluent (Department for Communities and Local Government, 2011). Across the south-west of England, out of the 300 most deprived areas (those in the most deprived 20% of all areas across England), only 11 were classified as rural (Oxford Consultants for Social Inclusion, 2009). Regardless, it is clear that rural populations face a unique set of challenges associated with physical activity behaviour, and they are clearly understudied in the United Kingdom. Little is known about the correlates of physical activity in adults living in rural villages in the United Kingdom and whether they are different from the correlates reported by urban residents. Therefore, it appears there is a need for studies investigating physical activity in rural settings, both in terms of the correlates of activity behaviour, and intervention effectiveness in such populations (Barnidge et al., 2013; Khan et al., 2009).

2.4 Conclusions

In this chapter, I presented the numerous study designs available for evaluating community-level physical activity interventions, and discussed their associated strengths and weaknesses. Additionally, the various techniques for measuring physical activity behaviour were outlined and discussed, and the differences in physical activity behaviour between rural and urban adults were characterised. In the next chapter, I present the results of two systematic

reviews I conducted; the first examines community-level physical activity interventions, and the second investigates the correlates of physical activity behaviour.

CHAPTER 3.

Systematic reviews of the literature

In the previous chapter, I described the various methodologies available for evaluating community-level physical activity interventions. I outlined the techniques available for measuring physical activity, and described the differences in physical activity between rural and urban adults. In this chapter, I present the results of two systematic reviews I conducted. The first review examines the effects of previously evaluated community-level physical activity interventions, exploring the different community settings, intervention components, and study designs used to date. The second review examines the personal, social, and environmental correlates of physical activity.

3.1 Systematic review of community-level physical activity interventions

Community-level physical activity interventions are routinely delivered using public funds, with little or no evaluation (House of Lords, 2011). Evaluation studies have demonstrated major design limitations and produced equivocal results (Baker et al., 2011; Dumbrowski, Sniehotta, Avenell, & Coyne, 2007). Many studies have failed to adequately describe the intervention, outline intervention components, and highlight the key differences between experimental and control conditions (Craig et al., 2008). Evaluations have also tended to use weak study designs, such as uncontrolled, before-and-after designs, rendering them unable to attribute any observed changes to the intervention (Baker et al., 2011). In a review of community-wide physical activity interventions, Baker et al. (2011) assessed none of the included studies to have

a low risk of bias, with selection bias the main concern. Only one study in this review randomised the intervention and comparison communities. The majority of studies used a controlled before-and-after design, incorporated only one post-intervention measurement, and observed different baseline characteristics between the intervention and comparison communities (Baker et al., 2011).

The House of Lords Select Committee stated that there is no excuse for weak evaluations, and recommended that rigorous evaluation plans should be in place before interventions are funded (House of Lords, 2011). Therefore, this review is needed to explore the effectiveness of community-level physical activity interventions that have been evaluated in recent years. The results of this review will be particularly useful for decision makers that have the responsibility of selecting the community-level physical activity interventions that receive funding.

The aim of this systematic review was to determine the effects of community-wide interventions, targeted at adults, upon community levels of physical activity. The review will particularly focus on community settings, intervention delivery mode, intervention components, theoretical perspectives, study design, evaluation measurements, population penetration, and intervention effectiveness.

3.2 Methods

Recent reviews of evaluations of community-level physical activity interventions were used to guide the development of the search strategy and study inclusion criteria for this systematic review of the literature (Baker et al., 2011; Bock, Jarczok, & Litaker, 2013). Wherever possible, the procedure used in this review followed the ‘Preferred Reporting Items for Systematic Reviews

and Meta-Analyses' (PRISMA) statement, developed to guide the reporting of systematic reviews (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

The database 'Medline' was searched for original research articles published between January 1st 1997 and July 24th 2013. The review start date was chosen to encompass fifteen years of studies, a sufficient time period to cover all recent publications. The following keywords and search strategy were chosen using 'Titles/Abstracts' search: ((“physical activity” OR “exercise” OR “walk”) AND (“health promotion” OR “intervention” OR “randomised controlled trial”) AND (“community” OR “community-level” OR “community setting”)).

3.2.1 Study inclusion criteria

In order to be included in the review, studies needed to evaluate interventions that explicitly aimed to increase physical activity in the community. For the purposes of this review, “community” was defined either as an administrative or geographic boundary area (e.g., city, town, village), or as a group of people who share at least one common or social characteristic (e.g., church community). The unit of analysis for this review was community; therefore, studies were excluded if they focused on specific populations that were not randomly selected from the community as a whole (e.g., clinically-defined subgroups).

In order to have a community-wide approach, interventions need to incorporate more than a singular strategy, because changing behaviour is a difficult task (Mummery & Brown, 2009). Therefore, using criteria from Baker et al. (2011), studies were only included if they used at least two broad strategies aimed at changing physical activity behaviour. Acceptable strategies include:

(1) Social marketing through local mass media (e.g., television, radio, newspaper).

(2) Other communication strategies (e.g., posters, flyers, information booklets) to raise awareness of the project and provide information.

(3) Individual counselling by health professionals (e.g., physical activity prescriptions).

(4) Working with voluntary, government, and non-government organisations (e.g., sporting clubs) to encourage participation in physical activity.

(5) Working within specific settings (e.g., community centres, churches, shopping centres).

(6) Environmental change strategies (e.g., walking trails, infrastructure, planning).

It was important that each included intervention used an integrated approach, where each strategy was incorporated in a comprehensive manner, therefore, an individual counselling intervention that just advertised using flyers would not be acceptable for inclusion.

A wide range of approaches and designs are used to evaluate health promotion interventions. Therefore, studies included in this review could have used any of the following study designs; randomised controlled trials, cluster randomised controlled trials, controlled before-and-after studies (no random assignment), and controlled interrupted time-series studies. Studies were included if they collected data on either repeated cross-sectional samples or cohort samples.

Only studies from developed countries were included in this review, given concerns for the variability in physical activity opportunities that may exist between developed, developing and least developed countries due to differences in lifestyles, social structures, and the built environment (Bock et al., 2013; World Health Organization, 2008). Limiting such variability will reduce the heterogeneity of findings, and improve the external validity of the review. This will help with the interpretation of the findings from the Devon Active Villages evaluation study, and to inform United Kingdom policy. The review also focused on studies that evaluated the physical activity levels of adults (aged 18 years and over), because child and youth physical activity behaviour comprises a separate body of literature.

Where possible, data was extracted on the proportion of participants achieving a sufficient level of physical activity, as defined by the United Kingdom recommended guidelines (≥30 minutes of moderate-intensity physical activity on ≥5 days per week, Department of Health, Physical Activity, Health Improvement and Protection, 2011), to enable cross-study comparisons. Studies that classified physical activity by proportion of participants classified as “active” or “inactive”, total minutes of physical activity, or measures of walking behaviour were also included. It was acceptable for physical activity to be measured using either objective or subjective measures, for example using pedometers, accelerometers, self-reported questionnaires, or diaries (Bassett, Mahar, Rowe, & Morrow, 2008).

3.2.2 Shortlisted studies

The Medline search produced *n* = 2495 hits. The reference lists of articles were further examined in an effort to identify all relevant publications,

producing an additional eight studies. Following the initial application of inclusion criteria to information contained in the study abstract, the number of hits was reduced to 88 studies. The pool of potentially eligible studies was reduced further to 26 studies, following review of the entire manuscript (Figure 3-1). 62 studies were excluded for varying reasons (Appendix C). Three interventions were evaluated in more than one article, these were “Romsas in Motion” (Jenum et al., 2006; Jenum et al., 2009), “10,000 steps Ghent” (De Cocker et al., 2007; De Cocker et al., 2011), and “Wheeling Walks” (Reger et al., 2002; Reger-Nash et al., 2005; Gebel et al., 2011). For the purposes of this review, articles that evaluated the same intervention were combined, meaning that 22 intervention studies were included in the final review (Brown et al., 2006; Brownson et al., 2004; Brownson et al., 2005; DeCocker et al., 2007; Eaton et al., 1999; Faridi et al., 2010; Jenum et al., 2006; Jiang et al., 2008; Kamada et al., 2013; Kloek et al., 2006; Lupton et al., 2003; Nafziger et al., 2001; NSW Health Department, 2002; O’Loughlin et al., 1999; Reger et al., 2002; Reger-Nash et al., 2006, 2008; Rissel et al., 2010; Thomas et al., 2012; Wendel-Vos et al., 2009; Wilcox et al., 2013; Zhang et al., 2003).

Each shortlisted study was evaluated using a custom abstraction form (Appendix D). The abstraction form assessed the mode of intervention delivery, intervention length, follow-up time period, community type, theoretical framework, study design, sample characteristics, and intervention penetration. Outcome measures of physical activity, and level of significance of any effects were also extracted, if reported.

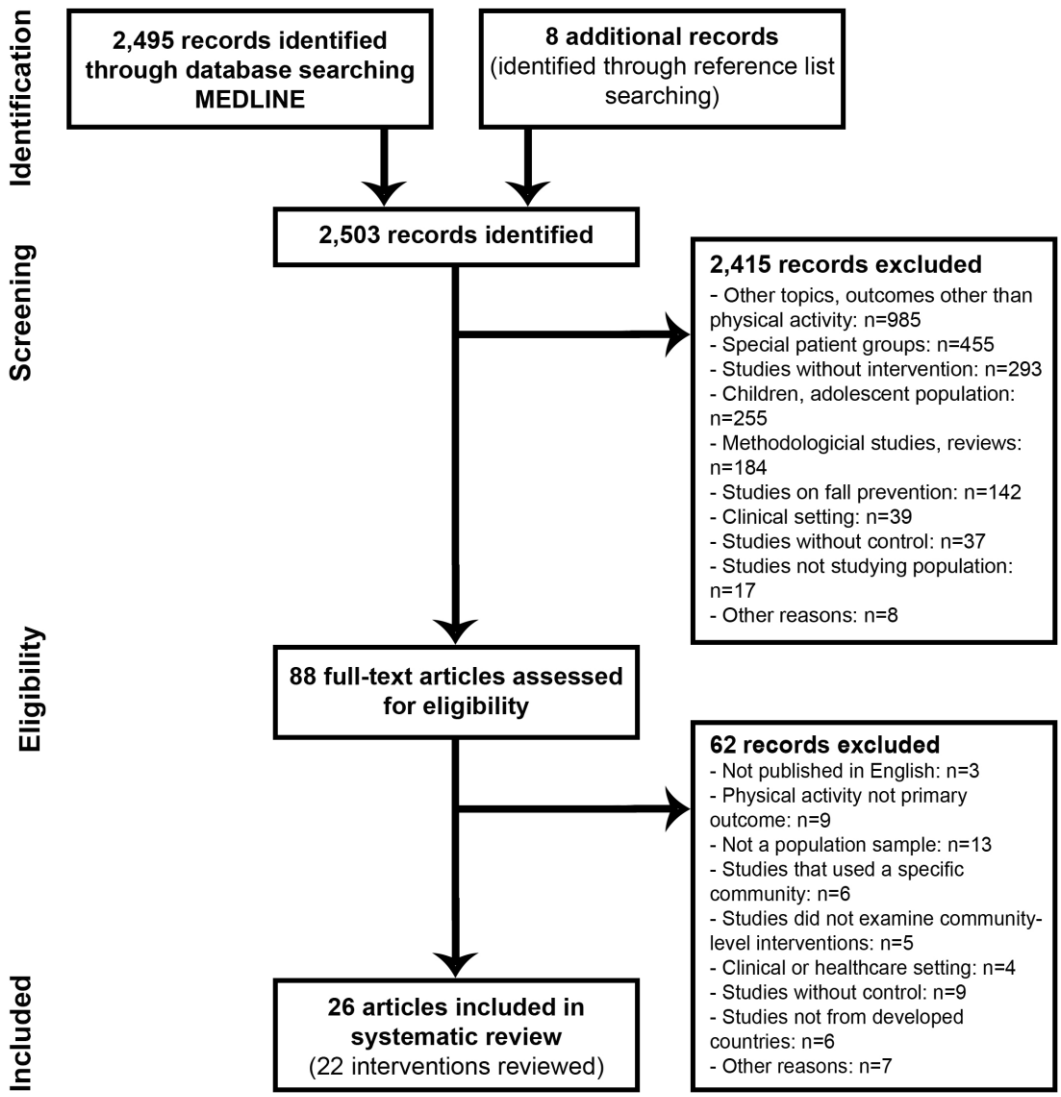


Figure 3-1 Flow chart on selection of articles for inclusion in the systematic review of community-level physical activity interventions.

3.3 Results

A summary of the interventions, outcomes and main findings from the included studies can be seen in Table 3-2.

Table 3-2 Description of interventions, outcomes, and main findings for community-level physical activity interventions.

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Controlled before-and-after studies with repeated cross-sectional samples					
Brown et al. (2006)	*Name:* 10,000 Steps Rockhampton *Target:* All residents *Aim:* Walking promotion intervention *Components:* Social marketing (mass media),website, logbooks, pedometers for sale and loan, individual counselling, partnering with organisations, workplace settings, and environmental change *Control:* No intervention *Duration:* 18 months *Theory:* Social ecological framework	*Intervention:* One city, Rockhampton (pop. 60,000) *Comparison:* One city, Mackay (pop.75,000) *Type:* Urban *Country:* Australia	Controlled before-and-after study with repeated cross-sectional samples (18-60 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Telephone interview, using the Active Australia questionnaire *Follow-up:* Two years	*Intervention:* Increase of 5% (95% CI -0.6 to 10.6) in proportion of women meeting physical activity recommendations, no change in men, 0.9% increase for both sexes (p>0.05). *Comparison:* Decrease of 6.4% in the proportion of men and women categorised as active.
Brownson et al. (2004)	*Name:* Bootheel Walking Promotion *Target:* All adult residents *Aim:* Walking promotion intervention *Components:* Individually tailored newsletters, individual counselling, community engagement, working with volunteers, community-wide events, and development of walking trails *Control:* No intervention *Duration:* Not reported *Theory:* None reported	*Intervention:* Six communities, Missouri “bootheel” region (pop. 2,399 to 17,642) *Comparison:* Six communities, Arkansas and Tennessee (pop. 2,399 to 17,642) *Type:* Rural *Country:* USA	Controlled before-and-after study with repeated cross-sectional samples (18+ years)	*Outcome:* Walking behaviour (minutes/week) *Instrument:* Telephone interview, using the Behavioral Risk Factor Surveillance System (BRFSS) *Follow-up:* One year	*Intervention:* Walking behaviour decreased slightly, but not significantly, compared with the comparison communities (p>0.05).
Brownson et al. (2005)	*Name:* Walk the Ozarks to Wellness *Target:* All residents *Aim:* Walking promotion intervention *Components:* Social marketing (media, newspaper articles), tailored newsletters, individual counselling, community engagement, walking trail events & clubs *Control:* No intervention *Duration:* Not reported *Theory:* Social ecological framework, Transtheoretical model	*Intervention:* Six communities, Missouri Ozark region (pop. not reported) *Comparison:* Six communities, Arkansas and Tennessee (pop. not reported) *Type:* Rural *Country:* USA	Controlled before-and-after study with repeated cross-sectional samples (18+ years)	*Outcome:* Rate of meeting walking recommendations, and walking behaviour (minutes/week) *Instrument:* Telephone interview, using the BRFSS survey *Follow-up:* One year	*Intervention:* Increase in walking behaviour was greater (+11.7 min/week), compared to comparison communities (+6.5 min/week), but not significantly (p>0.05). Proportion of adults meeting the walking recommendations did not differ between the communities at follow-up (p=0.811).

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Eaton et al. (1999)	*Name:* Pawtucket Heart Health Program *Target:* All residents *Aim:* Health promotion intervention *Components:* Self-help materials, partnering with local organisations, screening advice, working with schools, and environmental change (fitness trails) *Control:* No intervention *Duration:* Seven years *Theory:* Social learning model, Transtheoretical model	*Intervention:* One city, Pawtucket (pop. not reported) *Comparison:* One city, matched to intervention (pop. not reported) *Type:* Urban *Country:* USA	Controlled before-and-after study with repeated cross-sectional samples (18-64 years)	*Outcome:* Rate of physical inactivity *Instrument:* Not reported *Follow-up:* Eleven years (five follow-up surveys conducted at two-year intervals)	*Intervention:* There was no significant difference in rates of physical inactivity, compared to the comparison community (p=0.15). Rates of physical inactivity decreased significantly across both communities (p=0.001).
Jiang et al. (2008)	*Name:* Not reported *Target:* All residents aged 35-74 years *Aim:* Hypertension prevention intervention *Components:* quarterly handouts, information boards, individual counselling, partnering with councils, health education *Control:* No intervention *Duration:* Three years *Theory:* None reported	*Intervention:* One community, Chongwen, Beijing (pop. 50,000) *Comparison:* One community, Xicheng, Beijing (pop. 50,000) *Type:* Urban *Country:* China	Controlled before-and-after study with repeated cross-sectional samples (35-74 years)	*Outcome:* Rate of regular physical activity *Instrument:* Survey and physical examination, using a single unnamed question *Follow-up:* Three years	*Intervention:* Regular physical activity increased significantly (RR 1.20 95% CI 1.09 to 1.31, p<0.05).
NSW Health Department (2002)	*Name:* Walk It: Active Local Parks *Target:* All adult residents *Aim:* Walking promotion intervention *Components:* Social marketing (mass media), communication strategies, partnering with voluntary groups, changes to environment (park improvement). *Control:* No intervention *Duration:* One year *Theory:* None reported	*Intervention:* One community, Lachlan Macquarie ward (pop. not reported) *Comparison:* One community, Caroline Chisholm ward (pop. not reported) *Type:* Urban *Country:* Australia	Controlled before-and-after study with repeated cross-sectional samples (25-65 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Telephone interview, using an unnamed questionnaire *Follow-up:* One year	*Intervention:* No significant effect on proportion meeting activity recommendations (RR 1.08, 95% CI 0.99-1.17). There was a small decrease in physical activity attainment for both the intervention and comparison communities.

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Zhang et al. 2003	*Name:* Not reported *Target:* All residents *Aim:* Diabetes prevention intervention, *Components:* Health booklets delivered to all residents, health education lectures provided by local health advisors, individual counselling, health screening *Control:* No intervention *Duration:* Four years *Theory:* None reported	*Intervention:* One community, in Shandong (pop. 50,000) *Comparison:* One village, (pop. not reported) *Type:* Not reported *Country:* China	Controlled before-and-after study with repeated cross-sectional samples (25-75 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Physical examination and survey, using an unnamed questionnaire *Follow-up:* Four years	*Intervention:* There was no significant difference in proportion meeting physical activity recommendations (p>0.05). *Comparison:* There was a significant decrease in the proportion meeting physical activity recommendations (p<0.05).
Controlled before-and-after studies with cohort follow-up					
De Cocker et al. (2007) (De Cocker et al., 2011)	*Name:* 10,000 Steps Ghent *Target:* All adult residents *Aim:* Walking promotion intervention, *Components:* Mass media (newspaper, TV), communication strategies (flyers, posters, website), pedometers, workplace settings, events, environmental changes *Control:* No intervention *Duration:* One year intensive intervention, continued by community for three years *Theory:* Social ecological framework	*Intervention:* One city, Ghent (pop. 228,000) *Comparison:* One city, Aalst (pop. 77,000) *Type:* Urban *Country:* Belgium	Controlled before-and-after study with cohort follow-up (25-75 years)	*Outcome:* Walking behaviour (steps/day) *Instrument:* Pedometer and telephone interview, using the International Physical Activity Questionnaire (IPAQ) *Follow-up:* One year and four years	*Intervention:* After one year, walking behaviour increased by 896 steps/day, compared to a decrease of 135 steps/ day in comparison community (p<0.05). Pedometer data—proportion of adults achieving 10,000 steps/day increased by 8% (t=3.2, p=0.001), compared to no change in comparison community (t=1.3, p=0.21). After four years, walking behaviour increased by 108 steps/day (p>0.05) compared to baseline. Walking behaviour in comparison community decreased by 814 steps/day. There was a significant time by community interaction effect (p=0.008).

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Faridi et al. (2010)	*Name:* PREDICT *Target:* Adult church congregants *Aim:* Diabetes prevention intervention *Components:* Information boards, individual counselling, community health advice, group education sessions, community outreach events *Control:* No intervention *Duration:* Not reported *Theory:* None reported	*Intervention:* Thirteen African-American church communities, New Haven (pop. not reported) *Comparison:* Six African-American church communities, Bridgeport (pop. not reported) *Type:* Not reported *Country:* USA	Controlled before-and-after study with cohort follow-up (18+ years)	*Outcome:* Rate of meeting physical activity recommendations, and energy expenditure *Instrument:* Survey, using the 7-Day Physical Activity Recall (PAR) questionnaire *Follow-up:* 15 months	*Intervention:* No difference in proportion meeting physical activity recommendations compared to comparison churches (p=0.67). *Comparison:* Energy expenditure (kcal/kg/wk) increased significantly (131.3) compared to intervention churches (14.8; p=0.004).
Jenum et al. (2006) (Jenum et al., 2009)	*Name:* Romsas in Motion *Target:* All residents aged 30-67 years *Aim:* Physical activity intervention *Components:* Mass media, communication strategies (tailored leaflets, posters), individual counselling, partnering with health workers, activity groups, and environmental changes *Control:* No intervention *Duration:* Three years *Theory:* Social learning model, Social ecological framework, Community empowerment model	*Intervention:* One low-income district, Romsas, Oslo (pop. 6,700) *Comparison:* One low-income district, Furuset, Oslo (pop. not reported) *Type:* Urban *Country:* Norway	Controlled before-and-after study with cohort follow-up (30-67 years)	*Outcome:* Rates of heavy physical activity and no heavy physical activity *Instrument:* Physical examination and survey, using the Oslo Health Survey *Follow-up:* Three years	*Intervention:* Proportion of adults doing 'no heavy activity' reduced by 8.1% (95% CI 2.4 to 13.8, p=0.005), compared to the comparison community. Proportion of adults doing regular heavy activity increased by 9.5% (p=0.008), compared with the comparison community.
Kloek et al. (2006)	*Name:* Wijkgezondheidswerk (Working on Healthy Neighbourhoods) *Target:* All residents *Aim:* Health promotion intervention *Components:* Mass media, individual counselling, partnering with coalitions, and special events in schools *Control:* No intervention *Duration:* Two years *Theory:* Transtheoretical model, Attitude social influence-efficacy model	*Intervention:* Three low-income communities, Eindhoven (pop. not reported) *Comparison:* Three low-income communities, Eindhoven (pop. not reported) *Type:* Urban *Country:* Netherlands	Controlled before-and-after study with cohort follow-up (18-65 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Postal survey, using the Short Questionnaire to Assess Health Enhancing PA (SQUASH) *Follow-up:* Two years	*Intervention:* There was no significant difference in proportion of adults meeting the physical activity recommendations, compared to comparison community (p>0.05).

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Lupton et al. (2003)	*Name:* The Finnmark Intervention Study *Target:* All residents *Aim:* Health promotion intervention *Components:* Social marketing, individual counselling, physical training for adults with heart disease, subsidised activities, environmental change (cycle trails) *Control:* No intervention *Duration:* Three years *Theory:* Community empowerment model	*Intervention:* One village, Batsfjord, Finnmark (pop. 2,500) *Comparison:* Three villages, Loppa, Gamvik, and Masoy (pop. 5,000 combined) *Type:* Rural *Country:* Norway	Controlled before-and-after study with cohort follow-up (20-62 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Physical examination and survey, using the Finnmark Study Survey *Follow-up:* Six years	*Intervention:* Proportion of adults meeting physical activity recommendations increased but not significantly (p>0.05). Change in physical activity was significant for men (p=0.047), but not for women (p=0.15). *Comparison:* No change in proportion meeting activity recommendations (p>0.05).
Reger et al. (2002) (Reger-Nash et al., 2005; Gebel et al., 2011)	*Name:* Wheeling Walks *Target:* Sedentary residents aged 50-65 years *Aim:* Walking promotion intervention *Components:* Mass media, public relations, website, individual counselling (prescriptions for walking), partnering with organisations, and workplace settings *Control:* No intervention *Duration:* One year (8 week initial program with booster 9 months later) *Theory:* Theory of planned behaviour, Transtheoretical model	*Intervention:* One city, Wheeling, West Virginia (pop. not reported) *Comparison:* One city, Parkersburg, West Virginia *Type:* Not reported *Country:* USA	Controlled before-and-after study with cohort follow-up (50-65 years)	*Outcome:* Rate of meeting physical activity recommendations, and walking behaviour *Instrument:* Telephone interview, using an unnamed questionnaire *Follow-up:* Three months, six months, and twelve months	*Intervention:* At three months, proportion meeting physical activity recommendations did not differ to comparison city (p>0.05). Walking behaviour increased by 23%, compared to 6% decrease in comparison city (p<0.05). At 12 months, proportion meeting walking recommendations was significantly higher (OR 1.94, 95% CI 1.06 to 3.55), but there was no difference in physical activity behaviour (OR 1.24 95% CI 0.69 to 2.21) compared to comparison city.

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Reger-Nash et al. (2008)	*Name:* WV Walks *Target:* All residents aged 40-65 years *Aim:* Walking promotion intervention *Components:* Mass media (newspaper, TV, radio), website, partnering with organisations, environmental changes *Control:* No intervention *Duration:* Eight weeks *Theory:* Theory of planned behaviour, Transtheoretical model	*Intervention:* One community, West Virginia (pop. not reported) *Comparison:* One community, West Virginia (pop. not reported) *Type:* Not reported *Country:* USA	Controlled before-and-after study with cohort follow-up (40-65 years)	*Outcome:* Rate of meeting walking recommendations *Instrument:* Telephone interview, using an unnamed questionnaire *Follow-up:* Three months	*Intervention:* Proportion of adults meeting walking recommendations increased by 12%, compared to the comparison community (OR 1.82 95% CI 1.05 to 3.17)
Reger-Nash et al. (2006)	*Name:* BC Walks *Target:* Sedentary residents aged 40-65 years *Aim:* Walking promotion intervention *Components:* mass media (newspaper, TV, radio), website, public relations, and community health activities *Control:* No intervention *Duration:* Eight weeks *Theory:* Theory of planned behaviour, Transtheoretical model	*Intervention:* One county, Broome, New York (pop. 200,536) *Comparison:* One county, Chautauqua, New York (pop. not reported) *Type:* Not reported *Country:* USA	Controlled before-and-after study with cohort follow-up (40-65 years)	*Outcome:* Walking and physical activity behaviour (days/week) *Instrument:* Telephone interview, using the CDC Behavioral Risk Factor Surveillance System *Follow-up:* Three months	*Intervention:* 16% changed from inactive to sufficiently active walkers, compared to 11% in the comparison county (OR 1.71 95% CI 0.99 to 2.95) 47% reported any increase in total weekly walking time, compared with 36% in the comparison county (OR 1.66 95% CI 1.14 to 2.44; p<0.05).
Rissel et al. (2010)	*Name:* Cycling Connecting Communities (CCC) Project *Target:* All residents *Aim:* Cycling promotion intervention *Components:* Social marketing, distribution of cycling maps, community engagement activities (organised bike rides, events, cycling skills courses), and environmental change *Control:* No intervention *Duration:* Two years *Theory:* None reported	*Intervention:* Two suburbs, Liverpool & Fairfield, Sydney (pop. not reported) *Comparison:* One suburb, Bankstown, Sydney (pop. not reported) *Type:* Urban *Country:* Australia	Controlled before-and-after study with cohort follow-up (18+ years)	*Outcome:* Rate of meeting physical activity guidelines, physical activity behaviour (minutes/week), and cycling frequency *Instrument:* Telephone interview, using an unnamed questionnaire *Follow-up:* Two years	*Intervention:* There was no significant difference in proportion meeting physical activity recommendations (p=0.13), total physical activity (minutes/week; p>0.05), or proportion who had cycled in the past year (p>0.05), compared to the comparison community.

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Controlled before and after studies with cohort follow-up and repeated cross-sectional samples					
Nafziger et al. (2001)	*Name:* Ostego-Scholarie Healthy Heart Program *Target:* All residents *Aim:* Cardiovascular disease prevention *Components:* Mass media, communication strategies, partnering with organisations and volunteers, and health education *Control:* No intervention *Duration:* Five years *Theory:* None reported	*Intervention:* Two counties, Ostego and Scholarie, New York (pop. not reported) *Comparison:* One county, Herkimer, New York (pop. not reported) *Type:* Rural *Country:* USA	Controlled before-and-after study with cohort follow-up and repeated cross-sectional samples (20-69 years)	*Outcome:* Rate of physical inactivity *Instrument:* Telephone interview and survey, using the CDC Behavioral Risk Factor Surveillance System *Follow-up:* Six years	*Intervention:* Proportion of physically inactive adults decreased (from 72.5% to 60.9%), but not significantly (p>0.05). Comparison: No change in proportion of physically inactive adults (68%; p>0.05).
O'Loughlin et al. (1999)	*Name:* Coeur en santé St-Henri *Target:* All adult residents *Aim:* Cardiovascular disease prevention *Components:* Mass media, print education, videos, individual counselling, partnering with clubs, environmental changes *Control:* No intervention *Duration:* Five years *Theory:* Social learning model, Behavioural change theory of self-efficacy	*Intervention:* One low-income community, St Henri (pop. 25,000) *Comparison:* One low-income community, Centre-Sud (pop. not reported) *Type:* Urban *Country:* Canada	Controlled before-and-after study with cohort follow-up and repeated cross-sectional samples (18-65 years)	*Outcome:* Rate of meeting physical activity recommendations, and rate of physical inactivity *Instrument:* Telephone interview, using the Canadian Heart Health Survey *Follow-up:* Three years and five years	*Intervention:* At three years, rate of physical inactivity increased less (OR 1.9), than in the comparison community (OR 2.8, X^2=3.44, p=0.063). No difference in physical activity levels (p>0.05). At five years, there was no significant difference in physical activity or inactivity behaviour (p>0.05).
Wendel-Vos et al. (2009)	*Name:* Hartslag Limburg Intervention *Target:* All residents *Aim:* Cardiovascular disease prevention *Components:* Mass media, printed exercise guides, TV guided exercise, public health education, partnering with organisations, and school settings *Control:* No intervention *Duration:* Five years *Theory:* Transtheoretical model	*Intervention:* One city, Maastricht, Limburg (pop. not reported) *Comparison:* One city, Doetinchem, Gelderland (pop. not reported) *Type:* Urban *Country:* Netherlands	Controlled before-and-after study with cohort follow-up and repeated cross-sectional samples (20-59 years)	*Outcome:* Physical activity and walking behaviour (hours/week) *Instrument:* Physical examination and survey, using an unnamed questionnaire *Follow-up:* Five years	*Intervention:* No significant difference in physical activity or walking behaviour for men compared to comparison community (p>0.05). Women did significantly more walking (+2.2 hours/week), and physical activity (+2.1 hours/week) compared to comparison city (p<0.05).

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Cluster randomised controlled trials with cohort follow-up					
Kamada et al. (2013)	*Name:* COMMUNICATE (COMMUNIty wide CAmpaign To promote Exercise) *Target:* All residents aged 40-79 years *Aim:* Physical activity intervention *Components:* Social marketing (flyers, newsletters, audio broadcasts), health education program, social and material support (reflective material, pedometers). Four clusters:1) Walking only; 2) Stretching only; 3) Walking, stretching, and muscle strengthening promotion; 4) Control *Control:* No intervention *Duration:* One year *Theory:* None reported	*Intervention:* Nine communities, Unnan, Shimane (pop. not reported) *Comparison:* Three communities, Unnan, Shimane (pop. not reported) *Type:* Not reported *Country:* Japan	Cluster randomised controlled, superiority trial, stratified by high, moderate, and low population density, with cohort follow-up (40-79 years)	*Outcome:* Rate of meeting physical activity recommendations *Instrument:* Postal survey, using an unnamed questionnaire *Follow-up:* One year	*Intervention clusters (combined):* Proportion of adults meeting physical activity recommendations decreased from 63.9% to 58.7%, but not significantly (OR 0.97 95% CI 0.84 to 1.14) Comparison: Proportion of adults meeting physical activity recommendations decreased from 64.6% to 60.3% (p>0.05).
Thomas et al. (2012)	*Name:* Not reported *Target:* All residents over 60 years *Aim:* Physical activity intervention *Component:* Communication strategies, pedometers, buddy peer support, walking partners, organised events, monthly meetings, and exercise plans Four clusters: 1) Pedometer and buddy support; 2) Pedometer only; 3) Buddy support only; 4) Control *Control:* No intervention *Duration:* Twelve months *Theory:* None reported	*Intervention:* Eighteen community centres, (pop. not reported) *Comparison:* Six community centres (pop. not reported) *Type:* Not reported *Country:* Hong Kong	Cluster randomised controlled trial of community centres with cohort follow-up (60+ years)	*Outcome:* Physical activity behaviour (MET/min/week) *Instrument:* Physical examination and survey, using the International Physical Activity Questionnaire-Short Version (IPAQ-SV) *Follow-up:* One year	*Intervention:* Physical activity increased significantly by 1820 (95% CI 1360 to 2290) MET/min/week in pedometer group, and by 1260 (95% CI 780 to 17,460) MET/min/week in the buddy support group, compared to the comparison communities.

Table 3-2 (continued)

Study	Intervention	Communities	Study design	Outcome and measurement	Intervention effects
Wilcox et al. (2013)	*Name:* Faith, Activity, and Nutrition *Target:* Adult church congregants *Aim:* Physical activity and healthy diet intervention *Components:* Communication strategies (bulletin boards, pulpit messages), individual counselling, educational materials, physical activity practices *Control:* No intervention *Duration:* Fifteen months *Theory:* None reported	*Intervention:* 37 African Methodist Episcopal (AME) churches, South Carolina (pop. not reported) *Comparison:* 33 AME churches, South Carolina (pop. not reported) *Type:* Not reported *Country:* USA	Cluster randomised controlled trial with cohort follow-up (18+ years)	*Outcome:* Physical activity behaviour (hours/week) *Instrument:* Physical examination and survey, using the Community Health Activities Model Program for Seniors (CHAMPS) survey *Follow-up:* 15 months	*Intervention:* Leisure-time physical activity increased significantly (d=0.17, p=0.03), compared to the comparison churches.

3.3.1 Study communities

Of the twenty-two included studies, ten were conducted in North America (45.5%), five were conducted in Europe (22.7%), four in Asia (18.2%), and three in Australia (13.6%). None of the included studies were conducted in the United Kingdom. The communities targeted by the interventions varied from whole regions or counties (n=4), entire cities (n=4), urban communities within cities (n=8), rural communities (villages and towns, n=3), church communities (n=2), to community centres (n=1). Whether the intervention was conducted in urban (n=10) or rural (n=4) communities was only reported in fourteen studies. Of the studies that provided information on the population size of the intervention communities (n=9), populations ranged from 2,399 to 228,000.

3.3.2 Theoretical perspectives

The interventions were developed from a variety of theoretical perspectives. Eight studies sought to increase physical activity in the community by developing an intervention based on two or more theoretical models. The most frequently reported theory was the transtheoretical model (n=7), followed by the social ecological framework (n=4), the theory of planned behaviour (n=3), and the social learning model (n=3). Two studies reported using the behavioural change theory of self-efficacy, and two studies used the community empowerment model for developing their interventions. Ten studies did not identify any theoretical perspective in their papers.

3.3.3 Intervention components

Based on the intervention strategies outlined earlier (Baker et al., 2011), only one intervention study reported using all six strategies (10,000 Steps Rockhampton; Brown et al., 2006). Six intervention studies incorporated five of the strategies, twelve studies used four strategies, two studies used three strategies, and one study reported using only two of the outlined strategies. The most frequently reported strategies were ‘working with voluntary, government, and non-government organisations’ (n=21) and ‘other communication strategies’ (n=20). Fifteen interventions used ‘social marketing strategies’, and ‘individual counselling’, fourteen interventions ‘worked within specific settings’, and seven interventions incorporated ‘environmental changes’.

Nine interventions targeted all residents within the intervention community (39.1%), six interventions targeted all adults in the intervention community (26.1%), and seven interventions were targeted at more specific populations, typically middle-aged or elderly populations (34.8%). The shortest interventions lasted for only eight weeks (Reger-Nash et al., 2006; 2008), while the longest intervention lasted for seven years (Eaton et al., 1999). The most common intervention length was one year (n=4).

3.3.4 Study designs

Nineteen studies used controlled before-and-after studies (86.4%), with the remaining three studies using cluster randomised controlled trials (13.6%). Cohort samples were used in twelve studies (54.5%), repeated cross-sectional samples were used in seven studies (31.8%), and three studies

used both repeated cross-sectional and cohort samples (13.6%; Nafziger et al., 2001; O'Loughlin et al., 1999; Wendel-Vos et al., 2009). Sample sizes ranged from 276 to 15,261 individuals across the studies. Evaluation follow-up periods ranged from three months (Reger-Nash et al., 2006; 2008), to eleven years (Eaton et al., 1999). Eighteen studies conducted only one follow-up data collection (81.8%); the remaining four studies either had two (9.1%), three (4.5%), or five (4.5%) follow-up data collection time points.

3.3.5 Outcome measures

Although some of the studies measured a variety of outcomes, this review was only interested in the outcomes associated with physical activity behaviour. Several studies in this review included two or more physical activity outcomes. Outcomes ranged from the proportion of participants who met the recommended activity guidelines (n=14), measures of walking behaviour (n=7), sedentary behaviour (n=3), continuous measures of physical activity (n=3), to other measures (e.g., cycling behaviour, heavy physical activity). In order to measure physical activity, eleven studies used telephone interviews (50%), six used surveys at physical examinations (27.3%), four used mail surveys (18.2%), and one study failed to report the measurement method. The '10,000 Steps Ghent' intervention study was the only study to include objective measurements of physical activity, by using pedometers alongside a telephone interview (De Cocker et al., 2007). Thirteen studies used named validated surveys to measure physical activity behaviour (59.1%), with ten different questionnaires used in total. The remaining studies either failed to report the survey questions used, or used an unnamed questionnaire.

3.3.6 Intervention penetration

Six studies (27.3%) reported some form of population penetration data for the intervention being studied (Eaton et al., 1999; Jiang et al., 2008; Kamada et al., 2013; NSW Health Department, 2002; Reger et al., 2002; Reger-Nash et al., 2006). This ranged from crude intervention participation rates, proportion of the population participating in events, number of TV, radio, and/or newspaper advertisements, website hits, to the direct observation of park use. Eight studies reported some element of intervention awareness and/or participation by study participants (De Cocker et al., 2007; Kamada et al., 2013; Kloek et al., 2006; NSW Health Department, 2002; O'Loughlin et al., 1999; Reger et al., 2002; Reger-Nash et al., 2006; Rissel et al., 2010). Despite the 'Cycling Connecting Communities' intervention from Australia (Rissel et al., 2010) reporting the lowest awareness levels, the intervention community were still more aware of the project (13.5%), than the comparison community (8%; $p<0.05$). Intervention awareness was not measured at baseline, however. The intervention that achieved the highest awareness levels was the 'Wheeling Walks' intervention in the USA (Reger et al., 2002), where over 90% of the intervention community were aware of the intervention at follow-up. However, awareness levels in the comparison community were not reported.

3.3.7 Participant characteristics

Of the studies that reported the gender breakdown of the study participants, the proportion of females included in the study samples ranged

from 24% to 81% (median 54.5%). In the majority of studies, samples comprised of more females than males (71.4%). Of the studies that reported participant mean age, the median was 49 years (range 38 to 72 years). Ethnicity among the study populations ranged vastly, from one study where 99% of participants were Caucasian, to another where 100% of the participants were African American.

3.3.8 Intervention effect

Ten studies found that the intervention being studied had a significant positive effect on at least one physical activity outcome (Brown et al., 2006; De Cocker et al., 2007; Jenum et al., 2006; Jiang et al., 2008; Lupton et al., 2003; Reger et al., 2002; Reger-Nash et al., 2006; 2008; Thomas et al., 2012; Wilcox et al., 2013). One study found that the intervention under investigation was only effective among the women in the sample (Brown et al., 2006), while another study found the intervention was only effective at increasing physical activity levels for men (Lupton et al., 2003).

3.3.9 Specific interventions

‘10,000 Steps Rockhampton’ was an 18-month walking promotion campaign conducted in Australia (Brown et al., 2006). The intervention used mass media as well as other forms of communication to increase awareness of physical activity. Individuals were provided with access to pedometers and logbooks, a website promoting goal setting and self-monitoring, health professionals for counselling, and initiatives set-up in a number of specific settings. Collaborations with the local government led to improvements in

walking tracks, and the creation of signage and maps. After two years, the proportion of the intervention community categorised as being sufficiently physically active increased by 5% (95% CI -0.6 to 10.6) in women, but decreased by 4.2% (95% CI -10.1 to 1.7) in men, resulting in a 0.9% increase overall ($p>0.05$). In the comparison community, there was a downward trend in the proportion of adults who were classified as physically active, decreasing by 6.4%. A significantly lower proportion of the intervention community were classified as physically active at baseline, in relation to the comparison community (OR 0.77, 95% CI 0.65 to 0.93). Two years later, however, there was no difference between the communities for the proportion of adults who were sufficiently active (adjusted RR 1.18, 95% CI 0.60 to 2.35).

The ‘10,000 Steps Ghent’ intervention (De Cocker et al., 2007), implemented in Belgium, was based on and performed in cooperation with researchers from the ‘10,000 Steps Rockhampton’ intervention (Brown et al., 2006). Pedometer data revealed significant intervention effects for mean steps per day, where the intervention community increased by 896 steps per day (95% CI 599 to 1192), while the comparison community decreased by 135 steps per day (95% CI 432 to 162; $F=22.8$, $p<0.001$). The proportion of adults reaching the 10,000 steps per day target increased from 42% to 50% in the intervention community ($t=3.2$, $p=0.001$), but did not change in the comparison community (41% to 40%; $t=1.3$, $p=0.205$). Survey data revealed changes in walking behaviour and work-related physical activity significantly differed between the communities ($p<0.001$). The intervention community did more walking and work-related physical activity at follow-up, while the comparison community spent less time doing these behaviours. Participants

in the intervention community reported doing less moderate-intensity physical activity and leisure-time physical activity at follow-up. These declines in activity behaviour were, however, significantly lower than the declines in physical activity behaviour among the comparison community ($p<0.05$). The intervention achieved high rates of programme awareness among the intervention community (63.2%), significantly higher than in the control community (10.4%, $X^2=348.9$, $p<0.001$). After four years, the positive intervention effect was not maintained. In the intervention community, mean steps per day were no longer significantly higher than baseline (+108 steps/day; $p>0.05$). However, mean steps per day were still decreased in the comparison community (-814 steps/day); therefore, there was a significant time by community interaction effect ($p=0.008$; De Cocker et al., 2011).

Jenum et al. (2006) followed a cohort of individuals living in a low-income multi-ethnic district of Oslo before and after the physical activity intervention 'Romsas in Motion'. At baseline, the proportion of adults reporting no heavy activity was 5% higher in the intervention district, compared to the comparison district ($p<0.05$). After three years, there was a net reduction in the proportion of participants who reported no heavy activity (activity that makes them sweat and feel out of breath) in favour of the intervention district of 8.1% (95% CI 2.4 to 13.8, $p=0.005$). The proportion of the intervention district involved in some heavy activity also increased by 9.5% ($p=0.008$), compared to the comparison community.

Another intervention that produced positive effects on physical activity was a hypertension prevention intervention delivered to urban communities in China (Jiang et al., 2008). The intervention provided health education on

hypertension, including the associated health risks, as well as suggestions and encouragement to control or lower blood pressure (i.e., physical activity and diet advice). Substantial penetration into the community was achieved, through quarterly ‘door-to-door’ distribution of health education handouts, counselling by health practitioners, and a comprehensive hypertension screening campaign in which 73% of the community participated. The study revealed a significant increase in regular physical activity behaviour (adjusted RR 1.20, 95% CI 1.09 to 1.31) among the intervention community, compared to the comparison community ($p<0.05$).

Lupton et al. (2003) evaluated ‘The Finnmark Intervention Study’, a health and well-being promotion intervention delivered to a rural fishing village in Norway. The aim of the intervention was to influence the population to be more health conscious, to mobilise the inhabitants to participate in health promoting activities, and to change environmental factors influencing health. The intervention focused on community empowerment, giving individuals the opportunity to suggest health-promoting improvements in the intervention community. As well as environmental changes designed to facilitate healthy lifestyle choices, organised physical activity opportunities were created and promoted within the community. After six years, the proportion of males who were classified as physically active increased by 8.6% in the intervention community, significantly greater than the 0.6% rise in the comparison community ($p=0.047$). Among females, the proportion that were classified as physically active increased by 7.9% in the intervention community, compared to a 2.1% rise in the comparison community, but the difference between communities was not significant ($p=0.151$).

The ‘Wheeling Walks’ intervention (Reger et al., 2002) aimed to promote walking among sedentary and irregularly active adults aged 50-65 years in a city in West Virginia. The intervention incorporated paid television and radio advertisements, weekly press conferences and campaign events, work site programs, website exposure, health education programs, and physician “prescriptions for walking”. After one year, the intervention community were more likely to be sufficiently active walkers than the comparison community (OR 1.94, 95% CI 1.06 to 3.55). The intervention community were not, however, more likely to be sufficiently physically active in general (OR 1.24, 95% CI 0.69 to 2.21).

‘WV Walks’ was a walking promotion intervention in West Virginia that was based on the ‘Wheeling Walks’ intervention, and developed by the same researchers (Reger-Nash et al., 2008). The intervention aimed to promote walking to residents aged 40-65 years. In the intervention community, walking behaviour increased significantly, represented by an absolute shift of 12% of the target population from insufficiently active to sufficiently physically active, compared to the comparison community (OR 1.82, 95% CI 1.05 to 3.17).

Another walking promotion intervention based on the ‘Wheeling Walks’ design was ‘BC Walks’ based in Broome County, New York (Reger-Nash et al., 2006). Results indicated that there was a positive, but non-significant, trend for the proportion of intervention participants that changed from being inactive to sufficiently active walkers, compared to the comparison community (OR 1.71, 95% CI 0.99 to 2.95). In the intervention community, 47% of respondents reported increases in total weekly walking time at follow-up, compared with 36% in the comparison community (OR 1.66, 95% CI 1.14 to

2.44). 78% of the intervention community were aware of the ‘BC Walks’ intervention at follow-up, compared to 17% awareness of a fictitious intervention among the control community.

Thomas et al. (2012) evaluated a physical activity intervention delivered to twenty-four community centres for older adults in Hong Kong. Community centres were randomly allocated to different intervention groups; 1) pedometers and buddy support, 2) pedometers but no buddy support, 3) buddy support but no pedometers, and 4) no pedometers and no buddy support (comparison group). Centres allocated to the active intervention groups also received physical activity information and advice, monthly meetings and organised events (e.g., walks). In the centres allocated to receive pedometers, participants significantly increased their physical activity energy expenditure by 1820 (95% CI 1360 to 2290) metabolic equivalent (MET) minutes per week, relative to the comparison group ($p<0.05$). Participants in the centres assigned to receive buddy peer support also significantly increased their energy expenditure, relative to the comparison group, by 1260 (95% CI 780 to 17460) MET minutes per week ($p<0.05$). The intervention aimed to increase individual physical activity levels by at least 3500 steps per day (pedometer group), or 30 minutes per day (buddy support group), on three to five days per week. However, only 7.9% of the pedometer group, and 6.6% of the buddy support group achieved the targeted behaviour change.

Wilcox et al. (2013) evaluated a combined physical activity and dietary intervention aimed at regular church attendees in South Carolina. After controlling for baseline values of the outcome and all other covariates, self-

reported leisure-time moderate-to-vigorous intensity physical activity (MVPA) was higher at follow-up in the intervention churches, relative to the comparison churches (d=0.17, p=0.03). At follow-up, total MVPA was slightly higher in the intervention churches than in the comparison churches, however, the group by time interaction effect was not significant (d=0.15, p=0.06).

Twelve studies found no significant intervention effect on physical activity levels. Five studies reported positive trends in physical activity behaviour, as a result of the intervention, albeit not significantly (Brownson et al., 2005; Eaton et al., 1999; Nafziger et al., 2001; O'Loughlin et al., 1999; Zhang et al., 2003). Two studies reported no indication of any physical activity trends for either the intervention or comparison communities (Kloek et al., 2006; Rissel et al., 2010). The final five studies found that either physical activity levels decreased as a result of the intervention, or increased less in the intervention communities compared with the comparison communities (Brownson et al., 2004; Faridi et al., 2010; Kamada et al., 2013; NSW Health Department, 2002; Wendel-Vos et al., 2009).

Although not significant, Brownson et al. (2005) found that a rural walking promotion intervention resulted in greater changes in walking behaviour in the intervention communities (+11.7 minutes/week), compared to the comparison communities (+6.5 minutes/week; p>0.05). Eaton et al. (1999) evaluated a 7-year health promotion intervention aiming to reduce cardiovascular disease risk factors in the city of Pawtucket, USA. Overall physical inactivity decreased across the time period (p=0.001), however, there was no difference between intervention and comparison communities (p>0.05). In another cardiovascular disease prevention intervention (Nafziger

et al., 2001), the proportion of adults classified as physically inactive decreased from 72.5% to 60.9% in the intervention community, but not significantly ($p>0.05$), and remained stable in the comparison community (68%). In the evaluation of a Canadian cardiovascular disease prevention intervention, rate of physical inactivity increased less in the intervention community than in the comparison community, albeit not significantly ($p=0.063$; O'Loughlin et al., 1999). In an intensive diabetes prevention intervention in China, Zhang et al. (2003) found no difference in the proportion of the intervention community classified as physically active at follow-up ($p>0.05$). However, over the same time there was a significant reduction in the proportion of the comparison community classified as sufficiently physically active ($p<0.05$).

In both a health promotion intervention from the Netherlands (Kloek et al., 2006), and a cycling promotion intervention from Australia (Rissel et al., 2010), no significant differences or trends in physical activity behaviour were seen for either the intervention or control communities ($p>0.05$).

Brownson et al. (2004) evaluated a walking promotion intervention delivered to rural communities in the USA, finding that walking behaviour actually decreased slightly, but not significantly, in the intervention communities compared with the comparison communities ($p>0.05$). Similarly, another walking promotion intervention delivered to urban communities in Australia found small decreases in physical activity attainment in both the intervention and comparison communities at follow-up ($p>0.05$; NSW Health Department, 2002). Kamada et al. (2013) also found small decreases in both the intervention and comparison communities for the proportion of adults

classified as meeting the physical activity recommendations, during an evaluation of a Japanese physical activity intervention ($p>0.05$). In a diabetes prevention intervention aimed at church congregants (Faridi et al., 2010), the increase in energy expenditure found in comparison churches at follow-up, was significantly greater than increases seen in the intervention churches ($p=0.004$). There was, however, no significant difference in the proportion of individuals meeting the physical activity recommendations between the groups ($p>0.05$). In the evaluation of a five-year cardiovascular disease prevention intervention in the Netherlands, Wendel-Vos et al. (2009) found small decreases in leisure-time physical activity and walking behaviour in both the intervention and comparison communities ($p>0.05$). For men, there were no significant differences between the communities ($p>0.05$). Among women, leisure-time physical activity and walking behaviour decreased significantly less in the intervention community, compared to the comparison community ($p<0.05$).

3.4 Discussion

The results of the systematic review revealed very few evaluation studies of community-level interventions that aimed to increase population levels of physical activity, among adults from developed countries. These results are consistent with previous research, which has expressed the need for more evaluations of community-level physical activity interventions (Hills, 2004; House of Lords, 2011; National Institute for Health and Clinical Excellence, 2008). There is clearly a distinct lack of research into community-level physical activity interventions from the United Kingdom, with no studies

identified in this review. In concordance with previous research (Wilcox et al., 2000; Yousefian et al., 2010), only four of the included studies conducted interventions in rural locations, demonstrating how understudied these populations are. There were very few interventions delivered to village communities, with the smallest intervention population comprising of 2,399 people, meaning that no interventions were delivered to small village communities like those targeted in the Devon Active Villages intervention (500 to 2,000 people). Because there is a lack of comparable evaluation studies from the United Kingdom and small rural village communities, it will be difficult to interpret the results from the Devon Active Villages evaluation study in relation to other studies.

The included interventions were based on a large range of theoretical perspectives. However, almost half of the interventions failed to report any theoretical basis for the intervention. The Medical Research Council's guidance for the development and evaluation of complex interventions suggests that where possible interventions should be based on appropriate theory (Craig et al., 2008). However, in concordance with previous reviews (Baker et al., 2011), there was no evidence in this review to suggest that adherence to a particular theoretical framework was advantageous. There was also considerable heterogeneity in intervention strategies incorporated in this review.

Only three studies used cluster randomised controlled trials to evaluate interventions, with the remaining studies using controlled before-and-after designs. One of the limitations of controlled before-and-after designs is that they do not randomise the intervention and comparison communities. The

reasons why communities are selected to receive the intervention are often not reported, raising issues of selection bias (Delgado-Rodriguez & Llorca, 2004). If intervention communities are selected using convenience sampling or based on beliefs that the intervention will be effective in certain communities, this could result in intervention effects being over-inflated, and limit the generalisability of the findings to other populations (external validity). In another review of community-level physical activity interventions, only one study out of twenty-five used randomisation to allocate communities (Baker et al., 2011). In this review, the majority of studies included only one follow-up data collection, limiting their ability to follow intervention effects over time, and whether these effects are maintained long-term. Government reports have called for evaluations of community-level interventions to use rigorous study designs and incorporate multiple data collection time-points (House of Lords, 2011).

Only one study collected data using objective measures (pedometers; De Cocker et al., 2007), and this was only in a sub-sample of the population. The remaining studies used self-reported measures of physical activity, which tend to include bias due to social desirability, and may lead to some misclassification, with some participants finding it difficult to recall activities. Self-report measures are also associated with participants over-reporting physical activity levels, when compared with objective measures (e.g., Health Survey for England 2008; Craig et al., 2009). However, objective measures of physical activity are often not feasible for evaluation studies that use large population samples and multiple data collection time-points, due to the associated costs and logistics. The included studies measured a range of

physical activity outcomes using a variety of surveys. Many studies even failed to report the survey used, inhibiting the ability to interpret the results and draw conclusions.

Most of the studies did not report levels of population penetration, intervention awareness, and levels of participation in events for the interventions under investigation. Studies failing to measure or report this information make it difficult to determine an intervention's reach. Understanding the reach of an intervention is important when interpreting the results of the intervention. Some interventions may simply be ineffective in changing behaviour despite reaching large proportions of the population. However, in some cases interventions may be effective but fail to reach adequate proportions of the population in order to change population prevalence of physical activity. In the 'Wheeling Walks' intervention (Reger et al., 2002), over 90% of the intervention community were aware of the intervention. However, such high awareness levels only translated into small improvements in walking behaviour, and no improvement in physical activity attainment. The study also failed to report intervention awareness levels for the comparison community or either community at baseline, making it difficult to compare awareness levels with other studies. Similarly, the 'BC Walks' intervention (Reger-Nash et al., 2006), found high intervention awareness levels at follow-up. Instead of asking the comparison community about their awareness of 'BC Walks' they were instead questioned about their awareness of a fictitious walking intervention, making it difficult to interpret and compare the results.

In the study samples, females tended to be over-represented, and the median reported age of participants was approximately 50 years. This finding is in line with previous research that suggests that females and older adults are often over-represented in health surveys (Craig et al., 2009).

Just under half of the included studies found positive intervention effects on at least one measure of physical activity behaviour. However, positive intervention effects were not always maintained at later data collection periods (De Cocker et al., 2011), and some interventions were only effective for either males or females (Brown et al., 2006; Lupton et al., 2003). In addition, several studies only found positive intervention effects for alternative measures of physical activity (e.g., walking behaviour, heavy physical activity, or energy expenditure), rather than the proportion of individuals who were classified as sufficiently physically active. In eight out of the ten effective interventions, the main aim was to promote physical activity or walking behaviour, rather than physical activity being part of a wider health promotion intervention. This indicates that interventions that focus solely on physical activity behaviour may be the best bet for changing population prevalence.

Although the ‘10,000 Steps Rockhampton’ intervention (Brown et al., 2006) did not significantly increase physical activity behaviour in the intervention community, the downward trend in the proportion of adults classified as active in the comparison community was not evident in the intervention community. Compared to more general health promotion interventions, increasing walking behaviour in the community was the main aim of this intervention. Additionally, ‘10,000 Steps Rockhampton’ was the

only intervention included in the review that incorporated all six intervention strategies. Any positive intervention effects, were not, however, seen among the male population, with Brown et al. (2006) concluding that the “10,000 steps a day” message did not appeal to men. The results of this study were difficult to interpret because no sample sizes were reported, and the disparate physical activity levels at baseline were not adjusted for in the main analysis. Additionally, the researchers provided no reasons for the selection of the intervention community.

Strengths of the ‘10,000 Steps Ghent’ evaluation study included the use of pedometers to measure walking behaviour, relatively small loss to follow-up, and a long-term data collection time-point (De Cocker et al., 2007). Although the positive intervention effect was not maintained in the intervention community after four years, walking behaviour was still significantly higher compared to the comparison community. These results indicate the intervention community were able to maintain the intervention activities independently. The researchers reported that the communities were selected because of their demographic and geographic comparability, however, the variation in population size between the intervention (pop. 228,000) and comparison (pop. 77,000) communities suggests otherwise.

In the ‘Romsas in Motion’ intervention (Jenum et al., 2006), physical activity levels were significantly different between the communities at baseline, but were not adjusted for in the analysis. Instead, analyses focused on the changes in outcome variables for each participant between baseline and follow-up. The communities not being comparable at baseline complicates the findings, because there may be risk of selection bias and regression to the

mean in the intervention community. Jenum et al. (2006) attempted to select a comparison population that matched the intervention community on key factors, and at baseline the districts were comparable on most variables. Because the intervention and comparison districts neighboured one another, there was some possibility of contamination in the comparison district (e.g., mass media). Additionally, no sample size calculations were reported in the study.

In the Finnmark Intervention Study (Lupton et al., 2003), the researchers failed to comment on why they believed the intervention had a greater effect on males compared to females. Additionally the intervention community was chosen based on local initiative, rather than random sampling. The comparison communities were selected on the basis of similar age distribution, ethnic background, and reliance on fisheries. However, the comparison population was made up of three small villages, making it difficult to compare to the intervention population that all resided in one larger village. The intervention lasted three years, with baseline measures taken one year before the start of the intervention, and cohort follow-up measures taken two years after the intervention ended (six years between data collection time-points). The large timespan between baseline and follow-up means any observed behaviour changes may not be attributable to the intervention being studied. Significant events (e.g., national health promotion interventions, environmental changes) may have occurred in the time period between the intervention ending and the follow-up data collection occurring. Such events may have influenced the physical activity levels of the communities under investigation. Additionally, it is possible that the intervention had a greater

effect on physical activity behaviour, which subsided after the intervention was taken away, and before physical activity was measured at follow-up.

Wilcox et al. (2013) evaluated ‘Faith, Activity and Nutrition’, one of only a handful of faith-based interventions to have a positive effect on physical activity (Duru, Sarkisian, Leng, & Mangione, 2010; Kim et al., 2008; Resnicow et al., 2005), and one of the first that was designed to reach the entire congregation. The study did, however, report high attrition rates, with nearly 40% of participants providing no outcome measurements at the 15-month follow-up. A recent review found that high attrition (≥40%) was common in physical activity interventions for African Americans, particularly when follow-up exceeded six months (Pekmezi & Jennings, 2009). This study only targeted church settings, which could be seen as a limitation because participants are exposed to many other settings that influence behaviour (e.g., family, work, neighbourhood). However, it could also be argued that this is a strength of the intervention, because all efforts are focused on a single setting.

3.4.1 Strengths and limitations of the review

Strengths of this review include using a broad search strategy to produce a large number of initial database hits (n=2,495). This search strategy increased the likelihood of finding all of the studies that fitted the inclusion criteria. In addition to this, I searched the reference lists of the short-listed articles, in order to identify any additional studies that may have been missed by the initial search strategy. The findings in our review were in agreement with the findings of a similar review of community-wide physical activity interventions (Baker et al., 2011). However, the present review is up-

to-date and includes studies that have been published in the two years since the Baker et al. (2011) review was published.

Due to limited time and resources, only one database (Medline) was searched, and the review was conducted single-handed. This may have resulted in errors being made and suitable studies failing to be included. However, every effort was made to ensure the review was consistent and objective throughout. The usual procedure for systematic reviews involves at least two people reading through studies and checking abstraction forms. There may also have been some element of publication bias, where other studies may exist but may not have been submitted or accepted for publication, but the likelihood of this is difficult to judge.

The publication dates for inclusion in the study were somewhat arbitrary. The aim was to include studies from a fifteen-year period, so as to ensure the relevance of the included studies. However, setting strict publication dates may have resulted in important studies being excluded. Requiring studies to incorporate at least two intervention strategies resulted in a number of large-scale mass media interventions being excluded, such interventions may have included other strategies as part of their approaches, but failed to report these activities formally. Only studies from developed countries were included in the review, which limited the number of included studies, however, this did improve the generalisability of the findings. There was also a large amount of heterogeneity in the included studies, making it difficult to compare between studies.

3.5 Conclusions

Although numerous community-level physical activity interventions are undertaken, very few have been evaluated and the results published. There is a notable lack of evaluations that use rigorous study designs (e.g., cluster randomised controlled trials), studies from the United Kingdom, and interventions delivered to rural communities. The findings were inconsistent, with less than half of the included studies finding positive intervention effects for outcome measures of physical activity. The evidence provided does not support the hypothesis that multi-component community-level interventions effectively increase population prevalence of physical activity in adults.

In order to be effective in changing the behaviour of individuals and communities, interventions need to target the correlates of physical activity behaviour. Understanding the factors that influence physical activity behaviour in specific populations, will aid the development of effective, tailored intervention strategies aimed at increasing population prevalence of physical activity.

3.6 Systematic review of physical activity correlates

Understanding the factors that explain why some adults are regularly active while others are inactive is of utmost importance to public health research (Department of Health, Physical Activity, Health Improvement and Protection, 2011; Sallis, Owen, & Fotheringham, 2000). Correlates of physical activity behaviour are factors that are statistically associated with physical activity behaviour, but do not provide evidence of the causal relationship with physical activity (Bauman, Sallis, Dzewaltowski, & Owen, 2002).

Physical activity is a complex behaviour determined by the interaction of a large number of personal, social, and environmental factors, specific to populations, settings, and types of physical activity (Oliveira-Brochado et al., 2010; Sallis & Owen, 1997; Trost et al., 2002). Personal factors include biological and socio-demographic influences such as gender, age, body mass index, education, socio-economic status, health, and number of cars in the household. Social factors include psychological influences such as self-efficacy, perceptions of social support, and perceived barriers to being physically active. Environmental factors cover a range of influences, from perceived community attributes, walking environment, access to recreational facilities, to environmental aesthetics and perceived safety. Personal and social correlates of physical activity have been widely studied, whereas, environmental correlates are less studied, but thought to have widespread effects (Bauman et al., 2012).

Furthering the understanding of all types of influence on physical activity behaviour in specific populations, will aid the development of effective, tailored interventions aimed at increasing the population prevalence of physical activity (Sallis et al., 2000; Sallis, Owen, & Fisher, 2008). The aim of this systematic review was to investigate the correlates of physical activity behaviour in adults. The review will examine correlates across different settings, populations, and domains of physical activity.

3.7 Methods

A recent review of correlates of adult participation in leisure-time physical activity was used to guide the development of the search strategy

and study inclusion criteria for this systematic review of the literature (Kirk & Rhodes, 2011). Wherever possible, the procedure used in this review followed the PRISMA statement (Moher et al., 2009). The database 'Medline' was searched for original research articles published between January 1st 1997 and July 24th 2013. The review start date was chosen to encompass fifteen years of studies, a sufficient time period to cover all recent publications. The following keywords and search strategy were chosen using 'Titles' search: ((“correlate” OR “correlates” OR “determinants”) AND (“physical activity” OR “exercise” OR “walk”)).

3.7.1 Study inclusion criteria

In order to be included in the review, studies needed to identify at least one correlate of physical activity behaviour. Studies could focus on any domain of physical activity (leisure-time, occupational, household, or transportation activities). However, where possible, data was extracted on the proportion of participants achieving a sufficient level of physical activity, as defined by the United Kingdom recommended guidelines (≥30 minutes of moderate-intensity physical activity on ≥5 days of the week; Department of Health, Physical Activity, Health Improvement and Protection, 2011), to enable cross-study comparisons. It was acceptable for physical activity to be measured using either objective or subjective methods, including pedometers, accelerometers, self-reported questionnaires, or diaries (Bassett et al., 2008).

Studies were limited to those examining the physical activity behaviour of adults (aged 16 years and over), because child and youth physical activity comprises a separate body of literature. It was acceptable for studies to

include a sample of both males and females, or alternatively use an all male, or all female sample. Eligible studies could be from any geographic settlement type (e.g., rural, urban, sub-urban, mixed). Excluded studies were those that examined clinical populations, because the results may deviate from the general population, as a result of the health condition, limiting the external validity of the findings (Kirk & Rhodes, 2011).

A wide range of study designs and sampling strategies are used to examine the correlates of physical activity behaviour. Therefore, studies included in this review could be either cross-sectional or longitudinal, and could have used any of the following sampling strategies: multi-stage random sampling, stratified, random sampling, probability cluster sampling, simple random sampling, or convenience sampling.

Only studies from developed countries were included in this review, given concerns for the variability in lifestyles, socio-demographic variables, social structures, built environment, and physical activity opportunities that may exist between developed, developing, and least developed countries (World Health Organization, 2008). Limiting such variability will reduce the heterogeneity of findings and improve the external validity, aiding the interpretation of the findings from the Devon Active Villages evaluation study, and help inform UK policy. Only published articles in refereed journals and manuscripts accepted for publication were considered for this review. Additionally, only articles published in English were included.

3.7.2 Shortlisted studies

The Medline search produced n=693 hits. The reference lists of articles were further examined in an effort to identify all relevant publications. Following the initial application of inclusion criteria to information contained in the study abstract, the number of hits was reduced to 100 studies (Figure 3-3). After reviewing the entire manuscript, seventy-two studies were excluded for varying reasons (Appendix E). An additional three papers were identified and suggested for inclusion in this review by a third party researcher (Foster et al., 2009; Murphy, Donnelly, Shibli, Foster, & Nevill, 2012; Mytton, Townsend, Rutter, & Foster, 2012). Therefore, thirty-one studies were included in the final review (Bergman et al., 2008 [1]; Bertrais et al., 2004 [2]; Brownson et al., 2000 [3]; Brownson et al., 2001 [4]; Cleland et al., 2010 [5]; Cleland et al., 2011 [6]; De Bourdeaudhuij et al., 2005 [7]; Dowda et al., 2003 [8]; Eyler, 2003 [9]; Eyler et al., 2003 [10]; Foster et al., 2009 [11]; Garrett et al., 2012 [12]; Giles-Corti & Donovan, 2002 [13]; Hansen et al., 2013 [14]; Inoue et al., 2011 [15]; Janssen et al., 2013 [16]; Kaplan et al., 2001 [17]; Kim et al., 2010 [18]; Murphy et al., 2012 [19]; Mytton et al., 2012 [20]; Ogilvie et al., 2008 [21]; Orsini et al., 2007 [22]; Pan et al., 2009 [23]; Panter et al., 2012 [24]; Parks et al., 2003 [25]; Plotnikoff et al., 2004 [26]; Saelens et al., 2012 [27]; Sharpe et al., 2008 [28]; Shores et al., 2009 [29]; Van Dyck et al., 2011 [30]; Wilcox et al., 2000 [31]).

Each shortlisted study was evaluated using a custom abstraction form (Appendix F). The abstraction form included the authors, year of publication, study design, theoretical framework, country and location of study, sample

characteristics, physical activity outcome measure, correlates measured, study outcomes, and study strengths and limitations.

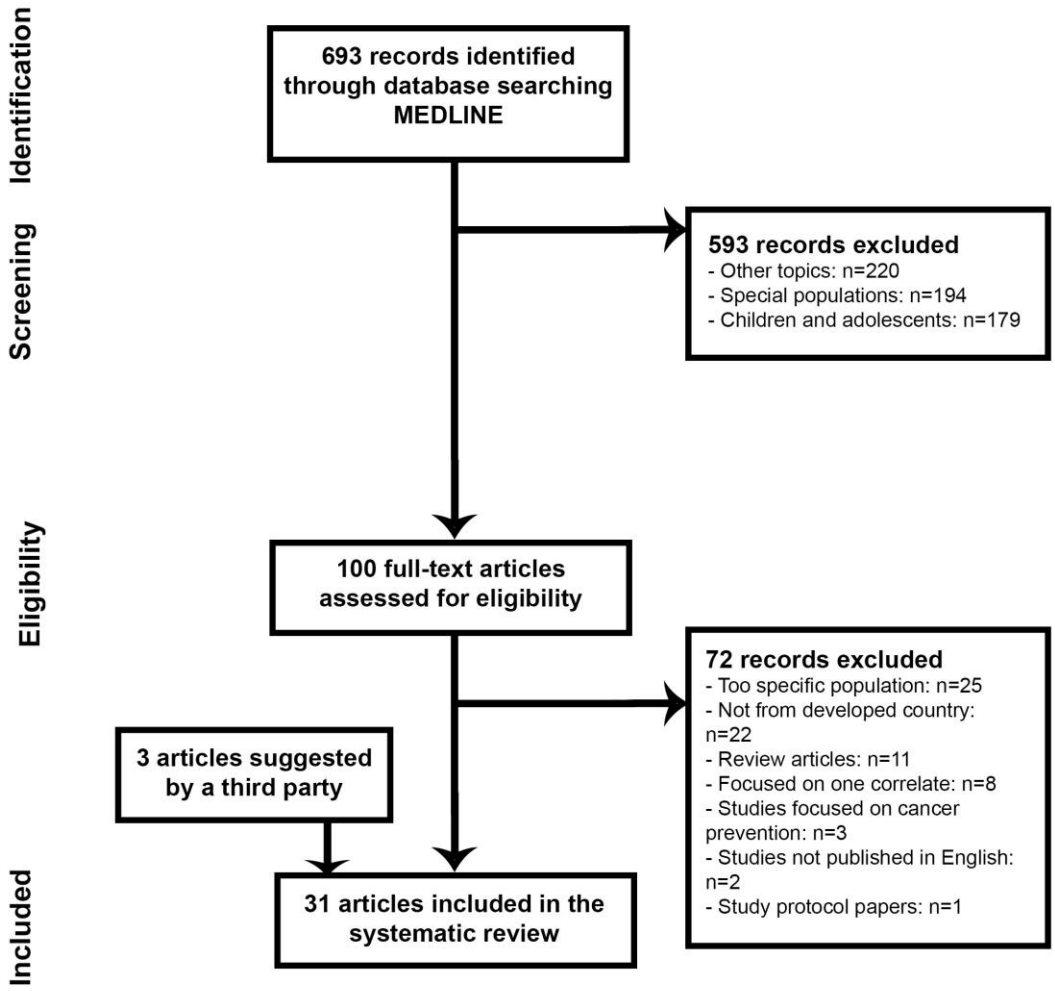


Figure 3-3 Flow chart on selection of articles for inclusion in the systematic review of physical activity correlates.

3.8 Results

A summary of the study designs, populations, measurements, and outcomes of the included studies can be seen in Table 3-4. Table 3-5

contains a summary of the correlates associated with physical activity behaviour of adults from the included studies.

Table 3-4 Description of study designs, populations, measurements, and outcomes for physical activity correlate papers.

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Longitudinal studies					
Janssen et al. (2013) [16]	Longitudinal study (15 years follow-up), with participants from the Longitudinal Study of Women's Health Across the Nation (SWAN) cohort, and a stratified random sample *Sample:* 54-64 years *N:* 90 participants *Response rate:* 72% *Theory:* Social determination theory, social cognitive theory, social network theory	*Country:* United States *Population:* Chicago *Type:* Urban *Age:* 59 years (mean) *Gender:* Females only *Race:* 57% White, 43% African American	*Outcome:* Physical activity frequency (participants classified as: 'high PA' or 'low PA'; and 'consistent PA', 'sporadic PA', or 'sedentary') *Instrument:* Survey at test centre, using Kaiser Physical Activity Survey (KPAS)	Age, race/ethnicity, income/socioeconomic status, self-efficacy, PA motivation, friend who is active	In the adjusted model, income (OR 3.90, [95% CI 1.54-9.84]), self-efficacy (2.49, [1.55-4.01]), and autonomous motivation (1.79, [1.13-2.82]) were all positively associated with physical activity. 61% of women with a history of consistent physical activity had a close friend who was currently physically active; in contrast, only 34% of sporadically active and 23% of sedentary women had a close friend who was physically active (p=0.008).
Cross-sectional studies with random nationally representative sample					
Bergman et al. (2008) [1]	Cross-sectional study, with random nationally representative sample *Sample:* 18+ years *N:* 1470 participants *Response rate:* 59% *Theory:* None reported	*Country:* Sweden *Population:* Whole country *Type:* Urban and rural (26.1% villages) *Age:* 46(15) years (mean(SD)) *Gender:* 52.9% female *Race:* Not reported	*Outcome:* Health enhancing physical activity (participants classified as: 'low', 'moderate', or 'high' active) *Instrument:* Postal survey, using short IPAQ	Age, gender, overweight/obesity, education, income/ socioeconomic status, health, smoking status, marital status, employment, residential community size	In the adjusted model, being male, 18-34 years old, normal weight, living in a village/small town, and very good self-rated health, was associated with greater odds of being in the 'high' active category (p<0.05). Similarly, being normal weight, a student, living in a village/small town, and in good health was associated with higher odds of being in the 'moderate' activity category (p<0.05).
Brownson et al. (2000) [3]	Cross-sectional study, with random nationally representative sample *Sample:* 40+ years *N:* 2912 participants *Response rate:* 87.3%	*Country:* United States *Population:* Whole country *Type:* Urban and rural (37.6% & 42.7% respectively) *Age:* 61.5% 50+ years *Gender:* Females only	*Outcome:* Leisure-time physical activity (participants classified as: 'meets recommended guidelines' or 'fails to	Age, overweight/ obesity, race/ethnicity, education, income/ socioeconomic status, smoking status, marital status, fruit/vegetable	Regular exercise was most common in 60-69 year olds (1.55, [1.14-2.13]), and least common in overweight women (0.69, [0.54-0.87]). African American (1.35, [1.08-1.68]) or American Indian/Alaskan Native (1.65, [1.33-

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Brownson et al. (2000) [3]	*Theory:* None reported	*Race:* 25.6% African American, 25.3% American Indian/Alaskan Native, 22.7% Hispanic, 26.4% White	meet recommended guidelines') *Instrument:* Telephone interview, using the BRFSS	consumption, rural/urban status	2.06]) women were more likely to be completely inactive than White women. Being completely inactive was more common among rural residents, current smokers, and persons not consuming five fruit/vegetables per day (p<0.05).
Garrett et al. (2012) [12]	Cross-sectional study, secondary analysis of a study, with stratified, random, nationally representative sample *Sample:* 18+ years *N:* 8038 participants *Response rate:* Not reported *Theory:* None reported	*Country:* New Zealand *Population:* Whole country *Type:* Not reported *Age:* Not reported *Gender:* Males & females *Race:* Not reported	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Postal survey, using unnamed questionnaire	Access to places for exercise, perceived local environmental barriers	Access to local places for exercise was positively associated with physical activity behaviour (p<0.05). Perceived local environmental barriers demonstrated negative (steep hills, crime, dogs) and positive (unmaintained footpaths) associations (p<0.05). The absence of perceived environmental barriers was strongly associated with increased activity (p<0.05).
Hansen et al. (2013) [14]	Cross-sectional study, with random nationally representative sample *Sample:* 18+ years *N:* 3867 participants *Response rate:* 34% *Theory:* Social-ecological framework	*Country:* Norway *Population:* Whole country *Type:* Urban and rural *Age:* 49.1(14.9) years (mean(SD)) *Gender:* Males & females *Race:* Not reported	*Outcome:* Overall physical activity (counts/min) *Instrument:* Survey at test centre, and accelerometer-measured PA	Age, gender, overweight/obesity, education, no children in household, health, smoking status, marital status, self-efficacy, perceived behavioural control, physical activity identity, social support from family/friends, perceived community attributes	Being young, male, in good health, a non-smoker, increased self-efficacy, perceived behavioural control, and greater physical activity identity were all positively associated with physical activity behaviour (p<0.05). Education, and being overweight/obese were inversely associated with physical activity behaviour (p<0.05).
Kaplan et al. (2001) [17]	Cross-sectional study, part of the Canadian Population Health Survey, with stratified, random nationally representative sample	*Country:* Canada *Population:* Whole country *Type:* Urban and rural *Age:* 65+ years *Gender:* Males & females *Race:* Not reported	*Outcome:* Monthly moderate physical activity (participants classified as: 'frequently active' or 'infrequently active')	Age, gender, overweight/obesity, education, smoking status, marital status, long-term illness, injury from previous PA,	Being male (1.29, [1.19-1.39]), higher education (1.35, [1.23 to 1.48]), and greater social support (1.06, [1.03-1.09) were all positively associated with being frequently active. In contrast, being older (0.48, [0.44-0.52]), higher BMI

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Kaplan et al. (2001) [17]	*Sample:* 65+ years *N:* 12,611 participants *Response rate:* 82.6% *Theory:* None reported		*Instrument:* Telephone interview, using the National Population Health Survey	mobility limitations, social support	(0.97, [0.96-0.97]), married (0.89, [0.84-0.95]), a current smoker (0.83, [0.78-0.89]), having a long-term illness (0.91, [0.89-0.93]), having an injury (0.75, [0.67-0.83]), and functional limitations (0.58, [0.54-0.62]) were all inversely associated with PA frequency.
Murphy et al. (2012) [19]	Cross-sectional study, with random nationally representative sample *Sample:* 16+ years *N:* 4653 participants *Response rate:* 54.6% *Theory:* None reported	*Country:* Northern Ireland *Population:* Whole country *Type:* Urban and rural *Age:* 28.7% 60+ years *Gender:* 57.6% female *Race:* Not reported	*Outcome:* Proportion of participants who met recommended guidelines (≥150 mins of MVPA per week) *Instrument:* Household interview, using the Active People Survey	Age, gender, socio-economic status, smoking status, leanness (overweight/obesity)	Lower age, being male, higher socio-economic status, leanness, and being a non-smoker were all positively associated with physical activity ($p<0.05$).
Mytton et al. (2012) [20]	Cross-sectional study, with random nationally representative sample *Sample:* 16+ years *N:* 31,049 participants *Response rate:* Not reported *Theory:* None reported	*Country:* England *Population:* Whole country *Type:* Urban and rural (18.7% rural) *Age:* 41 (26-58) years (median (IQR)) *Gender:* 55.5% female *Race:* 76.2% White, 13.3% Asian, 6.9% Black, 3.7% Other	*Outcome:* Proportion of participants who met recommended guidelines (≥5x30min of MVPA per week) *Instrument:* Household interview, using the Health Survey for England questionnaire	Green space	There was a significant association between green space and physical activity, after controlling for individual and local environmental factors ($p<0.001$).
Wilcox et al. (2000) [31]	Cross-sectional study, part of the US Women's Determinants Study, with random nationally representative sample *Sample:* 40+ years *N:* 2338 participants *Response rate:* 87.3% *Theory:* None reported	*Country:* United States *Population:* Whole country *Type:* Urban and rural (53.1% rural) *Age:* 60% 50+ years *Gender:* Females only *Race:* Mixed (White, African American, Hispanic, American Indian/Alaskan native)	*Outcome:* Leisure-time physical activity (participants classified as: 'sedentary', 'underactive', or 'active') *Instrument:* Telephone interview, using the BRFSS	Age, overweight/ obesity, race/ethnicity, education, mobility limitations, no. of sick days, barriers to regular activity, social support, seeing others exercising, aesthetics, perceived safety in environment, traffic,	For urban and rural women, older age, greater perceived barriers to activity, and less social support were associated with being classified as 'sedentary' ($p<0.05$). For rural women, being American Indian/Alaskan Native (0.57, [0.40-0.81]) or African American (0.65, [0.43-1.00]), lower education (1.53, [1.16-2.01]), not having enjoyable scenery in the neighbourhood (1.71,

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Wilcox et al. (2000) [31]				presence of pavements/ street lighting/ unattended dogs/ hills, places to exercise	[1.16-2.53]), and not frequently seeing others exercise in the neighbourhood (1.39, [1.06-1.81]) were associated with being classified as 'sedentary' ($p<0.05$).
Cross-sectional studies with random sample					
Brownson et al. (2001) [4]	Cross-sectional study, with random-digit-dialed sample *Sample:* 18+ years *N:* 1818 participants *Response rate:* 61% *Theory:* None reported	*Country:* United States *Population:* Various locations *Type:* Urban and rural *Age:* 42.5% 45+ years *Gender:* 67.1% female *Race:* 53.4% White, 30% Black, 16.2% Other	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Telephone interview, using the BRFSS	Social support from family/friends, barriers to regular activity, can find exercise partner, friends/relatives to exercise with, seeing others exercising, aesthetics, perceived safety in environment, traffic, presence of pavements/ street lighting/ unattended dogs/ hills/ foul air from cars/factories, places to exercise, access to park/ gym/health club/ walking/jogging trail/ streets for exercise/ shopping mall/ treadmill	Access to parks (1.95, [1.52-2.52]), indoor gyms (1.94, [1.45-2.60]), and treadmills (1.48, [1.13 to 1.93]) were positively associated with likelihood of meeting the recommended guidelines. The presence of pavements (1.28, [1.02-1.59]), aesthetics (1.46, [1.13-1.88]), traffic (1.28, [1.04-1.58]), and hills (1.28, [1.04-1.58]), were also positively associated with physical activity. Social factors associated with physical activity included many people exercising (1.33, [1.09-1.64]), friends who encouraged exercise (1.23, [1.00-1.52]), and having friends with whom to exercise (1.45, [1.15-1.81]). Having barriers to regular PA was inversely associated with physical activity ($p<0.05$).
Cleland et al. (2010) [5]	Cross-sectional study, part of the Resilience for Eating and Activity Despite Inequality (READI) study, with random sample *Sample:* 18-45 years *N:* 4108 participants *Response rate:* 34.4% *Theory:* Social-	*Country:* Australia *Population:* Victoria *Type:* Urban and rural *Age:* 18-45 years *Gender:* Females only *Race:* Not reported	*Outcome:* Leisure-time physical activity (participants classified as: 'inactive', 'irregularly active' or 'meets recommended guidelines') *Instrument:* Postal survey, using long IPAQ	Dog ownership, childcare availability, self-efficacy, social support from friends/ family, enjoyment, outcome expectancies, behavioural intentions, behavioural skills, social cohesion, walking environment,	In the adjusted model, the odds of being classified as 'irregularly active' or 'meets recommended guidelines' were significantly higher for increasing self-efficacy (3-12% higher odds), enjoyment of PA (+5%), PA intentions (+15-40%), behavioural skills (+23-46%), available childcare (+40%), family support (+10-11%), friend support (+6-15%), compared to the odds of being

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Cleland et al. (2010) [5]	ecological framework			aesthetics, personal safety in environment	classified as 'inactive'.
Cleland et al. (2011) [6]	Cross-sectional study, part of the Childhood Determinants of Adult Health study, with stratified random sample *Sample:* 26-36 years *N:* 2017 participants *Response rate:* 56.1% *Theory:* None reported	*Country:* Australia *Population:* Whole country *Type:* Urban and rural (70% rural) *Age:* 31(2.6) years (mean(SD)) *Gender:* Males & Females *Race:* Not reported	*Outcome:* Daily steps and leisure-time physical activity (participants classified as: 'low', 'moderate', or 'high' active) *Instrument:* Survey at test centre, using long IPAQ, and pedometer-measured PA	Age, overweight/ obesity, education, smoking status, health, mental health, part-time employment, live births, alcohol intake, food intake, rural/ urban status	For both sexes, education (inversely), being a smoker, physical health, and mental health were all associated with physical activity ($p<0.05$). For men, being obese (-1162, [-1847 - -477]), and rural (-1.76, [-3.15 - -0.36]) was inversely associated with physical activity. For women, being in part-time employment (2.77, [1.36-4.18]), consuming extra foods (3.97, [1.07-6.87]), and in fair/poor health (inversely; -1786, [-2667 to -906]) were all associated with physical activity.
Dowda et al. (2003) [8]	Cross-sectional study, with participants enrolled in the NHANES III study, and random sample *Sample:* 18-30 years *N:* 4152 participants *Response rate:* Not reported *Theory:* None reported	*Country:* United States *Population:* Various locations *Type:* Not reported *Age:* 24 years (mean) *Gender:* 51% female *Race:* 76% White, 24% Black/ Mexican American	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Household interview and medical examination, using unnamed questionnaire	Age, overweight/ obesity, race/ethnicity, education, health, smoking status, marital status, employment, alcohol intake, pregnant, weight loss, social support	Non-Hispanic Black men ($p<0.001$) and non-Hispanic White women ($p=0.002$) were the most active. For both sexes, education, not being married, losing weight, and social support were all positively associated with physical activity behaviour ($p<0.05$). For females, not being employed ($p=0.04$), having a lower BMI ($p=0.003$), and good health ($p=0.01$) were also positively associated with physical activity.
Eyler (2003) [9]	Cross-sectional study, with random-digit-dialed sample *Sample:* 20-50 years *N:* 1000 participants *Response rate:* 52.1% *Theory:* None reported	*Country:* United States *Population:* Missouri & Illinois *Type:* Rural *Age:* 54.6% 40-50 years *Gender:* Females only *Race:* Not reported	*Outcome:* Physical activity status (participants classified as: 'inactive', 'irregularly active', or 'meets recommended guidelines') *Instrument:* Telephone	Age, education, income, children in household, health, marital status, employment, self-efficacy, know people who exercise, seeing others exercise, belong	Being younger (1.63, [1.12-2.37]), having a higher income (2.76, [1.08-4.01]), being employed (1.58, [1.17-2.15]), and having positive social roles (1.04, [1.01-1.08]), were all positively associated with the likelihood of meeting the recommended guidelines. There were mixed outcomes for the

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Eyler (2003) [9]			interview, using unnamed questionnaire	to community groups, attend religious services, social issues, social roles, sense of community, traffic, presence of pavements/ street lighting/ unattended dogs, places within walking distance, places to exercise	association between health, street lighting at night and physical activity. No other variables were significant in the adjusted regression model.
Eyler et al. (2003) [10]	Cross-sectional study, with random-digit-dialed sample *Sample:* 20-50 years *N:* 1000 participants *Response rate:* 52.1% *Theory:* None reported	*Country:* United States *Population:* Seven locations *Type:* Urban and rural *Age:* 20-50 years *Gender:* Females only *Race:* Native American, African American, Latina and White	*Outcome:* Physical activity status (participants classified as: 'inactive', 'irregularly active', or 'meets recommended guidelines') *Instrument:* Telephone interview, using unnamed questionnaire	Age, education, income, children in household, health, marital status, employment, self-efficacy, know people who exercise, seeing others exercise, belong to community groups, attend religious services, social issues, social roles, sense of community, rural/urban	For White rural women, age (inversely), income, employment, and social roles were associated with physical activity. In African American urban women, employment (inversely), no children in household, not belonging to community groups, and social roles were associated with physical activity. No children in household, health, self-efficacy, knowing people who exercise, seeing others exercise, and attending religious services were associated with physical activity for African American rural women. Being married, children in the household, health, self-efficacy, seeing others exercise, and social roles were associated with PA for African American women from mixed neighbourhoods. Being young, married, seeing others exercise, not belonging to community groups, and attending religious services were associated with physical activity for urban Latina women. For Native Americans from mixed neighbourhoods, being married,

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Eyler et al. (2003) [10]					health, self-efficacy, knowing people who exercise, belonging to community groups, and attending religious services were associated with physical activity.
Foster et al. (2009) [11]	Cross-sectional study, with random sample from general practice recruitment *Sample:* 45-74 years *N:* 13,927 participants *Response rate:* Not reported *Theory:* None reported	*Country:* England *Population:* Norfolk *Type:* Urban and rural *Age:* mean ~ 62 for males, 61 for females *Gender:* 56% female *Race:* 0.5% males and 0.2% females were non-white	*Outcome:* 4 different physical activities (recreational cycling, recreational walking, facility-based physical activity, and swimming) *Instrument:* Health check, using the EPIC Physical Activity Questionnaire 2 (EPAQ2)	Age, socio-economic status, education, cars in household, income, long-term illness, green space, personal safety (crime), traffic, access to places for exercise, access to swimming pool	Younger age, higher socio-economic status, education, and income were all positively associated with the four PA behaviours ($p<0.05$). Access to green space and area levels of crime were not associated with walking for recreation ($p>0.05$). Distance to facilities had either no or only a small effect on the uptake of different activities. Greater local traffic density was associated with less cycling behaviour for women (0.42, [0.32-0.52]) and men (0.41, [0.33-0.50]).
Giles-Corti & Donovan (2002) [13]	Cross-sectional study, with probability cluster random sample *Sample:* 18-59 years *N:* 1773 participants *Response rate:* 52.9% *Theory:* None reported	*Country:* Australia *Population:* Perth *Type:* Urban *Age:* 31% 45+ years *Gender:* 68% female *Race:* Not reported	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Telephone interview, using unnamed questionnaire	Age, gender, education, income, children in household, marital status, behavioural skills, PA intentions, access to beach/ golf course/ gym/health club/ park/ river/ sport centres/ swimming pools/ tennis courts, places to exercise	Being male, never married, no children in the household, higher levels of education, greater household income, behavioural skills, and greater PA intentions were all positively associated with the likelihood of meeting the guidelines ($p<0.05$). Additionally, having access to a park, river, and tennis courts were also positively associated with the likelihood of meeting the recommended guidelines ($p<0.05$).
Inoue et al. (2011) [15]	Cross-sectional study, part of a larger physical activity environment study, with stratified random sample *Sample:* 18+ years	*Country:* Japan *Population:* Four cities *Type:* Urban *Age:* 48.3(13.7) years (mean(SD)) *Gender:* 53.3% female	*Outcome:* Mean steps/day (participants classified as: 'sedentary to low active', 'somewhat active', or 'active to	Age, gender, overweight/obesity, education, children in household, health, marital status, cars in household,	Overall, self-rated health (1.70, [1.18-2.43]), being employed (1.67, [1.06-2.63), no cars in household (2.40, [1.28-4.49]), and owning a dog (1.77, [1.13-2.76]) were positively associated with the likelihood of being classified as

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Inoue et al. (2011) [15]	*N:* 790 participants *Response rate:* 19.8% *Theory:* None reported	*Race:* Not reported	highly active') *Instrument:* Postal survey, using unnamed questionnaire, and accelerometer-measured PA	employment, dog ownership	'active to highly active'. However, when examining the sexes individually, self-rated health, education (inversely), and having no cars in the household were only associated with physical activity for men (p<0.05), while being employed, and owning a dog were only associated with PA for women (p<0.05).
Ogilvie et al. (2008) [21]	Cross-sectional study, with random sample *Sample:* 16+ years *N:* 1322 participants *Response rate:* 15.9% *Theory:* None reported	*Country:* Scotland *Population:* Glasgow *Type:* Urban *Age:* 48 (16-89) years (median (range)) *Gender:* 61% female *Race:* Not reported	*Outcome:* Active travel (participants classified as: 'high', 'moderate', or 'low' active) *Instrument:* Postal survey, using short IPAQ	Age, home ownership, access to a bicycle, proximity to shops, road safety for cyclists	In the fully adjusted model, active travel was associated with age (inversely; 0.98, [0.97-0.99]), home ownership (1.70, [1.13-2.58]), access to bicycle (1.57, [1.06-2.33]), proximity to shops (1.20, [1.02-1.41]), and road safety for cyclists (inversely; 0.83, [0.70-0.98]).
Ogilvie et al. (2008) [21]	Cross-sectional study, with random sample *Sample:* 16+ years *N:* 1322 participants *Response rate:* 15.9% *Theory:* None reported	*Country:* Scotland *Population:* Glasgow *Type:* Urban *Age:* 48 (16-89) years (median (range)) *Gender:* 61% female *Race:* Not reported	*Outcome:* Active travel (participants classified as: 'high', 'moderate', or 'low' active) *Instrument:* Postal survey, using short IPAQ	Age, home ownership, access to a bicycle, proximity to shops, road safety for cyclists	In the fully adjusted model, active travel was associated with age (inversely; 0.98, [0.97-0.99]), home ownership (1.70, [1.13-2.58]), access to bicycle (1.57, [1.06-2.33]), proximity to shops (1.20, [1.02-1.41]), and road safety for cyclists (inversely; 0.83, [0.70-0.98]).
Pan et al. (2009) [23]	Cross-sectional study, part of the 2002 Physical Activity Monitor study, with random sample *Sample:* 15-79 years *N:* 5167 participants *Response rate:* 51% *Theory:* Social-ecological model	*Country:* Canada *Population:* Whole country *Type:* Urban and rural *Age:* 43.5(15.7) years (mean(SD)) *Gender:* 55.2% female *Race:* Not reported	*Outcome:* Proportion of participants who met recommended guidelines (based on MET hours) *Instrument:* Telephone interview, using IPAQ	Education, income, health, self-efficacy, barriers to regular PA, behavioural intentions, general social support, perceived health benefits, access to places for exercise	Being in poor health (inversely; 0.42, [0.29-0.61), higher education levels (1.85, [1.32-2.59]), family income (1.69, [1.25-2.29]), PA intentions (1.38, [1.27-1.50]), self-efficacy (1.50, [1.41-1.59]), health benefits of PA (1.17, [1.05-1.31]), and barriers to exercise (inversely; 0.94, [0.88 to 0.99]) were associated with likelihood of meeting the recommended guidelines.

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Panter et al. (2012) [24]	Cross-sectional study, with random sample *Sample:* 16+ years *N:* 486 participants *Response rate:* 68% *Theory:* None reported	*Country:* England, UK *Population:* Cambridge *Type:* Urban and rural (55.5% urban) *Age:* 43.1 years (mean) *Gender:* 70% female *Race:* Not reported	*Outcome:* Minutes per day of MVPA, and total reported daily time in MVPA *Instrument:* Postal survey, using Recent Physical Activity Questionnaire (RPAQ), and accelerometer-measured PA	Age, overweight/ obesity, education, health, children/adults in household, access to a bicycle, occupational activity, home ownership, cars in household, deprivation, long-term illness, mental health, percentage of greenspace, rural/ urban status	Reported MVPA was associated with education level (inversely; -50.53, [-93.33 - -7.73]), having a standing/ manual occupation (117.89, [75.47-160.32]), mental health (72.02, [26.06-117.98]), and access to a bicycle (99.98, [44.06-155.91]). In contrast, recorded MVPA, was only inversely associated with the number of adults in the household (-11.37, p=0.047), and percentage of greenspace (-9.63, p=0.036).
Parks et al. (2003) [25]	Cross-sectional study, with random-digit-dialed sample *Sample:* 18+ years *N:* 1818 participants *Response rate:* 61% *Theory:* None reported	*Country:* United States *Population:* Various locations *Type:* Urban and rural *Age:* % 45+ years ~ 35.2% (urban) to 61.4% (rural) *Gender:* 56.8% to 74.7% female *Race:* White, Black and other	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Telephone interview, using the BRFSS	Age, gender, race/ ethnicity, education, income, social support from family/friends, barriers to regular PA, friends/relatives to exercise with, access to park/ gym/ walking/ jogging trails/ shopping mall/ treadmill/ other PA equipment, places to exercise, rural/urban status	Age (inversely), being White, number of barriers (inversely), access to a park, walking/jogging trails, treadmill, and other equipment for exercise were all associated with physical activity for urban adults. For suburban adults, access to a shopping mall (inversely), walking/jogging trails, social support from friends and family, and having friends and family to exercise with, were all associated with physical activity. Number of places to exercise was associated with physical activity for both urban and rural adults. Having access to a gym was associated with physical activity for all neighbourhood types.
Plotnikoff et al. (2004) [26]	Cross-sectional study, part of a large provincial household survey study, with random sample *Sample:* 18+ years	*Country:* Canada *Population:* Ontario province *Type:* Urban and rural (87.7% & 12.3% respectively) *Age:* 32.5% 45+ years *Gender:* 49.7% female	*Outcome:* Leisure-time physical activity energy expenditure *Instrument:* Household interview, using US National Health	Age, overweight/ obesity, education, health, employment, marital status, occupational activity, alcohol intake, injury	22.7% of the variance in men's physical activity was predicted by correlates; proportion of friends who exercise, injury from previous activity (inversely), education (inversely), self-rated health, employment (inversely), and alcohol

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Plotnikoff et al. (2004) [26]	*N:* 20,606 participants *Response rate:* 37.8% *Theory:* None reported	*Race:* 44.5% Canadian, 20.3% Canadian and other, 35.2% other	Interview Survey	from previous PA, mobility limitations, pain limitations, know people who exercise	intake (inversely). 19.4% of the variance in women's physical activity was explained by several correlates; proportion of friends who exercise, occupational PA, injury from previous PA (inversely), education (inversely), and mobility limitations (inversely).
Saelens et al. (2012) [27]	Cross-sectional study, with random sample *Sample:* 20-65 years *N:* 2199 participants *Response rate:* 26% *Theory:* None reported	*Country:* United States *Population:* Seattle, Baltimore, and Washington *Type:* Not reported *Age:* 45.2(10.9) years (mean(SD)) *Gender:* 47.9% female *Race:* 74.3% White/non-Hispanic, 25.7% non-white	*Outcome:* Mean MVPA minutes per day, and self-reported leisure-time walking *Instrument:* Postal survey, using IPAQ, and accelerometer-measured PA	Age, gender, race/ ethnicity, education, income, marital status, adults in household, cars in household, time at current address, employment, self-efficacy, barriers to regular activity, places to exercise	Being male, White, employed, access to places for exercise, and high exercise self-efficacy were all positively associated with MVPA minutes per day ($p<0.05$). In contrast, age, number of cars in household, being married, and barriers to exercise were all inversely associated with MVPA minutes per day ($p<0.05$).
Sharpe et al. (2008) [28]	Cross-sectional study, with random-digit-dialed sample *Sample:* 18+ years *N:* 1176 participants *Response rate:* Not reported *Theory:* None reported	*Country:* United States *Population:* Two counties, South Carolina *Type:* Not reported *Age:* African Americans~ 41(15.3) years, White~ 45(16.2) years (mean(SD)) *Gender:* Females only *Race:* 37.7% African American, 62.3% White	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Telephone interview, using the BRFSS	Age, race/ethnicity, education, children in household, employment, self-efficacy, can find exercise partner	For African American women, having children in household (2.08, [1.29-3.37]), and high self-efficacy levels ($F=27.51$, $p<0.01$) were positively associated with likelihood of meeting the recommended guidelines. For White women, only high self-efficacy levels ($F=45.89$, $p<0.01$) were positively associated with likelihood of meeting the recommended guidelines.
Shores et al. (2009) [29]	Cross-sectional study, with random sample *Sample:* 65+ years *N:* 454 participants *Response rate:* 24% *Theory:* Social-ecological framework	*Country:* United States *Population:* North Carolina *Type:* Rural *Age:* 57% 65-74 years *Gender:* 46.8% female *Race:* 94.9% White, 4% Native American, 1% other	*Outcome:* Proportion of participants who met recommended guidelines *Instrument:* Postal survey, using 7-day Recall questionnaire	Social support, walking environment, perceived safety in environment, access to park, places within walking distance, access via transportation	Likelihood of meeting the recommended guidelines was associated with perceived social support ($p=0.01$), personal safety in environment ($p=0.01$), and having places for exercise within walking distance ($p=0.01$).

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
Van Dyck et al. (2011) [30]	Cross-sectional study, part of the Belgian Environmental Physical Activity Study (BEPAS), with random sample *Sample:* 20-65 years *N:* 1166 participants *Response rate:* 58% *Theory:* None reported	*Country:* Belgium *Population:* 24 neighbourhoods *Type:* Not reported *Age:* 42.7(12.6) years (mean(SD)) *Gender:* 52.1% female *Race:* Not reported	*Outcome:* Recreational walking, moderate-to-vigorous-intensity physical activity, and counts/day *Instrument:* Household interview, using Dutch IPAQ, and accelerometer-measured PA	Self-efficacy, social support from family/ friends, barriers to regular activity, walking environment, aesthetics, access to home PA equipment, places to exercise	Accelerometer-based MVPA was associated with self-efficacy (95% CI 0.05-0.14), fewer perceived barriers (-0.1- -0.02), higher walkability scores (0.01-0.03), less aesthetically pleasing environment (-0.08 - -0.01), and having PA equipment at home (0.01-0.04). For self-reported physical activity; walkability (0.03-0.09), social support from family (0.03-0.18), and self-efficacy (0.03-0.28) were associated with recreational walking. Social support from family (0.02-0.14) and friends (0.04-0.17), and self-efficacy (0.04-0.22) were associated with moderate-intensity leisure-time PA.
Cross-sectional studies with convenience sample					
Bertrais et al. (2004) [2]	Cross-sectional study, with participants from the Supplementation en Vitamines et Mineraux Antioxydants (SUVIMAX) study, and convenience sample *Sample:* 45-70 years *N:* 7404 participants *Response rate:* Not reported *Theory:* None reported	*Country:* France *Population:* Whole country *Type:* Urban and rural (17.5% rural) *Age:* 45-68 years (range) *Gender:* 54% female *Race:* Not reported	*Outcome:* Leisure-time physical activity (participants classified as: 'inactive/irregularly active', or 'meets recommended guidelines') *Instrument:* Postal survey, using Modifiable Activity Questionnaire (MAQ)	Age, education, smoking status, time spent watching TV	Participants aged 60+ years were twice as likely to meet recommended guidelines, than participants aged 45-49 years ($p<0.05$). Current smoking status was inversely associated with meeting the guidelines ($p<0.05$). Educational level was positively associated with meeting the guidelines in women ($p<0.05$), but not in men ($p>0.05$). After adjustment, television viewing was not significantly associated with meeting the guidelines ($p>0.05$).
De Bourdeaudhuij et al. (2005) [7]	Cross-sectional study, and convenience sample (worksites, libraries etc.) *Sample:* 18+ years *N:* 526 participants	*Country:* Portugal and Belgium *Population:* Two cities *Type:* Urban *Age:* Portugal~ 35.1(11.5) years, Belgium~37.2 (12.3) years (mean(SD))	*Outcome:* Physical activity minutes in usual week *Instrument:* Survey hand-outs at locations, using long IPAQ	Social support from friends, barriers to PA, benefits of PA, social norm, access to home PA equipment, land-use mix	In Portugal, social norm ($p\leq0.001$), and benefits of physical activity ($p<0.05$) were positively associated with total MVPA. In Belgium, social support from friends ($p<0.05$), barriers to PA (inversely; $p<0.05$), land-use mix

Table 3-4 (continued)

Paper	Study design	Population	PA outcome and measurement	Correlates measured	Findings
De Bourdeaudhuij et al. (2005) [7]	*Response rate:* Not reported *Theory:* None reported	*Gender:* 65% female *Race:* Not reported			(p<0.05), and access to PA equipment at home (p<0.05) were all associated with total MVPA.
Kim et al. (2010) [18]	Cross-sectional study, and convenience sample *Sample:* 20+ years *N:* 481 participants *Response rate:* Not reported *Theory:* None reported	*Country:* South Korea *Population:* Nineteen villages *Type:* Rural *Age:* 46 years (mean) *Gender:* 50.9% female *Race:* Not reported	*Outcome:* Proportion of participants who met recommended guidelines, (participants also classified as: 'active' (any exercise) or 'sedentary) *Instrument:* Household interview, using unnamed questionnaire	Age, education, children in household, health, marital status, employment, self-efficacy, barriers to regular activity, benefits of PA, active social activities	In men, self-efficacy was the only determinant associated with likelihood of meeting the recommended guidelines (OR 1.04, p=0.001). In women, being 40-64 years (ref: 20-39 years) was inversely associated with physical activity (0.07, p=0.03). Additionally, being married with no children in the household was positively associated with physical activity for women (10.88, p=0.02).
Orsini et al. (2007) [22]	Cross-sectional study, part of the Swedish Mammography Cohort (SMC87) study, and convenience sample *Sample:* 48-83 years *N:* 38,988 participants *Response rate:* 70% *Theory:* None reported	*Country:* Sweden *Population:* Vastmanland & Uppsala County *Type:* Not reported *Age:* 62(9) years (mean(SD)) *Gender:* Females only *Race:* Not reported	*Outcome:* Total daily physical activity (METs) *Instrument:* Postal survey, using unnamed questionnaire	Age, overweight/ obesity, education, smoking status, employment, part-time work, postmenopausal status, rural/urban status during childhood	Total physical activity was positively associated with being younger, having a lower body mass index, being post menopausal, not being a current drinker or smoker, lower levels of education, being employed part-time, and growing up in the countryside (p<0.05).

Table 3-5 Summary of the correlates associated with physical activity in adults.

Factor	No. of studies	Positive effect	No effect	Negative effect	Mixed effect	Study references
Personal factors						
Age	23	1	9	8	5	1,2,3,6,8,9,10,11,13,14,15,16,17,18,19,21,22, 24,25,26,27,28,31
Gender (male)	8	6	2	-	-	1,13,14,15,17,19,25,27
Overweight/obesity	11	-	3	7	1	1,3,8,14,15,17,19,22,24,26,31
Race/ethnicity (non-White)	7	-	2	2	3	3,8,16,25,27,28,31
Education	21	5	9	3	4	1,2,3,6,8,9,10,11,13,14,15,17,18,22,23,24,25, 26,27,28,31
Income/socioeconomic status	11	6	4	-	1	1,3,8,9,10,11,13,16,17,19,23,25
Deprivation	1	-	1	-	-	24
Employment	9	3	4	-	2	1,8,9,10,15,18,22,27,28
Part-time work (ref. full-time)	2	2	-	-	-	6,22
Standing/manual occupation	2	-	-	-	2	24,26
Owns home	2	1	1	-	-	21,24
Time at current address	1	-	1	-	-	27
Married	12	-	8	3	1	1,3,8,9,10,13,14,15,17,18,26,27
2 or more adults in household	2	-	1	-	1	24,27
No children in household	8	-	5	2	1	9,10,13,14,15,18,24,28
Live births	1	-	1	-	-	6
Childcare availability	1	1	-	-	-	5
At least 1 car in household	4	-	-	2	2	11,15,24,27
Access to a bicycle	2	1	-	-	1	21,24
Dog ownership	2	2	-	-	-	5,15
Health	11	7	2	-	2	1,6,8,9,10,14,15,18,23,24,26
Mental health	2	1	-	-	1	6,24
Long-term illness	3	-	1	1	1	11,17,24
Number of sick days	1	-	1	-	-	31
Mobility limitations	3	-	1	2	-	17,26,31
Pain limitations	1	-	-	1	-	26
Injury from previous PA	2	-	-	2	-	17,26
Postmenopausal status	1	1	-	-	-	22
Currently pregnant	1	-	1	-	-	8
Weight loss	1	1	-	-	-	8

Table 3-5 (continued)

Factor	No. of studies	Positive effect	No effect	Negative effect	Mixed effect	Study references
Non-smoker	9	4	3	2	-	1,2,3,6,8,14,17,19,22
Alcohol intake	3	-	2	1	-	6,8,22
Fruit/veg consumption (5 a day)	1	-	1	-	-	3
Time spent watching TV	1	-	1	-	-	7
Social factors						
Self-efficacy	10	8	1	-	1	5,9,10,14,16,18,23,27,28,30
Social support (general)	5	3	1	1	-	8,19,23,29,31
Social support from family	5	2	2	-	1	4,5,16,25,30
Social support from friends	6	3	1	-	2	4,5,7,14,25,30
Relatives to exercise with	2	-	1	-	1	4,25
Friends to exercise with	2	1	-	-	1	4,25
Can find exercise partner	2	-	1	1	-	4,28
Know people who exercise	2	-	1	-	1	9,10
Seeing others exercise	4	1	1	-	2	4,9,10,31
Social norms	1	-	-	-	1	7
Social cohesion	1	-	1	-	-	5
Social roles	2	1	-	-	1	9,10
Social issues	2	-	2	-	-	9,10
Sense of community	2	-	2	-	-	9,10
Autonomous motivation	1	1	-	-	-	16
Perceived behavioural control	1	1	-	-	-	14
Physical activity identity	1	1	-	-	-	14
Outcome expectancies	1	-	1	-	-	5
Behavioural intentions	2	2	-	-	-	5,23
Behavioural skills	1	1	-	-	-	5
Barriers to regular activity	8	-	1	4	3	4,7,18,23,25,27,30,31
Benefits of regular activity	2	-	1	-	1	7,18
Perceived health benefit	1	1	-	-	-	23
Physical activity enjoyment	1	1	-	-	-	5
Active social activities	1	-	1	-	-	18
Belongs to community groups	2	-	1	-	1	9,10
Attends religious services	2	-	1	-	1	9,10

Table 3-5 (continued)

Factor	No. of studies	Positive effect	No effect	Negative effect	Mixed effect	Study references
Environmental factors						
Perceived community attributes	1	-	1	-	-	14
Perceived local environmental barriers	1	-	-	1	-	12
Walking environment	3	1	2	-	-	5,29,30
Percentage of green-space	3	1	1	-	1	11,20,24
Aesthetics	4	1	1	1	1	4,5,30,31
Personal safety (e.g., crime)	6	1	5	-	-	4,5,9,11,29,31
Road safety for cyclists	1	-	-	1	-	21
Traffic	4	1	2	-	1	4,9,11,31
Presence of pavements	3	1	2	-	-	4,9,31
Presence of street lighting	3	-	2	-	1	4,9,31
Presence of unattended dogs	3	-	3	-	-	4,9,31
Presence of foul air from cars	1	-	1	-	-	4
Presence of hills	2	1	1	-	-	4,31
Land-use mix	1	-	-	-	1	7
Access to places for exercise	9	2	4	-	3	3,9,11,12,13,23,25,27,31
Places within walking distance	2	1	1	-	-	9,29
Access via transportation	1	-	1	-	-	29
Access to park	3	2	1	-	-	4,13,29
Access to beach	1	1	-	-	-	13
Access to river	1	1	-	-	-	13
Access to golf course	1	-	1	-	-	13
Access to gym, health club	2	1	1	-	-	4,13
Access to sport centres	1	-	1	-	-	13
Access to swimming pools	2	-	2	-	-	11,13
Access to tennis courts	1	-	1	-	-	13
Access to walking/jogging trail	1	1	-	-	-	4
Access to streets for exercise	1	-	1	-	-	4
Access to shops/shopping mall	2	1	1	-	-	4,21
Access to PA home equipment	3	2	-	-	1	4,7,30
Access to indoor walking facilities	1	-	1	-	-	28

Table 3-5 (continued)

Factor	No. of studies	Positive effect	No effect	Negative effect	Mixed effect	Study references
Adequate number of parks, trails, recreation areas	1	-	1	-	-	28
Knows of jogging/walking routes	1	-	1	-	-	28
Knows of cycling routes	1	-	1	-	-	28
Rural location	6	1	2	2	1	1,2,3,6,24,25
Grew up in city	1	-	-	1	-	22

3.8.1 Study design

Of the 31 included studies, thirty studies (96.8%) used a cross-sectional study design. Only one study incorporated a longitudinal study design, following participants for fifteen years (Janssen et al. 2013). Twenty-seven studies used random sampling strategies (87.1%), while four studies used convenience sampling (12.9%). Eight studies (25.8%) used randomly selected nationally representative samples.

3.8.2 Study locations

Fourteen studies were conducted in North America (45.2%), eleven studies were conducted in Europe (35.5%), four studies in Australasia (12.9%), and two studies in Asia (6.5%). Five of the European studies were conducted in the United Kingdom (Foster et al., 2009; Murphy et al., 2012 Mytton et al., 2012; Ogilvie et al., 2008; Panter et al., 2012). The communities examined in the included studies varied from whole countries (n=10), provinces/counties (n=6), cities (n=6), neighbourhoods (n=3), to villages (n=1). Five studies examined a variety of community types in their investigations. Of the studies that provided information on the urban/rural breakdown of the study population, five studies were set in urban locations (17.9%), three studies were set in rural locations (10.7%), and seventeen were set in a combination of rural and urban settings (ranging from 12.3% to 70% rural).

3.8.3 Sample characteristics and response rates

Nineteen studies included general adult populations (16 years and over; 61.3%), six studies focused on middle-aged populations (45 years and over; 19.4%), three studies focused on younger adults (16-30 years; 9.7%), and two

studies focused on adults aged 65 and over (6.5%). Twenty-three studies included both males and females (74.2%), while eight studies only included females (25.8%). Of the nineteen studies that reported sample breakdowns by gender, females were overrepresented in sixteen studies (more than 50% female; 84.2%). Number of participants in the included studies ranged from 90 to 38,988, with a median of 1818 participants. The response rates to the survey studies ranged from 15.9% to 87.3%, with a median of 55%.

3.8.4 Theoretical perspectives

The majority of studies did not identify any theoretical perspective in their papers (80.6%). Five articles sought to examine physical activity correlates based on a social-ecological framework (16.1%). One study reported using the social determination theory, social cognitive theory, and the social network theory as the theoretical basis for their study (Janssen et al., 2013).

3.8.5 Outcome measures

The studies measured a range of physical activity outcomes, from the proportion of participants who met recommended guidelines (n=17), minutes of physical activity per day (n=3), physical activity counts per day (n=2), daily steps (n=2), recreational walking (n=2), physical activity frequency (n=2), four different activity behaviours (n=1), to active travel (n=1).

Ten studies measured outcomes using telephone interviews (32.3%), ten studies used postal surveys (32.3%), six studies conducted household interviews (19.4%), four studies measured outcomes during visits to test centres (12.9%), and one study handed out questionnaires at various locations (3.2%). Twenty-five studies only used subjective measures of physical activity (e.g.,

self-report questionnaires), five studies used a combination of subjective and objective (e.g., accelerometers, pedometers) measures, and one study only used accelerometers to measure physical activity (Hansen et al., 2013). The International Physical Activity Questionnaire (IPAQ) was the most commonly reported survey measure used, reported in eight studies (six studies used the IPAQ long form, and two used the IPAQ short form). Five studies reported using the Behavioral Risk Factor Surveillance System. The remaining studies reported using a variety of different surveys including the Recent Physical Activity Questionnaire (RPAQ), Modifiable Activity Questionnaire (MAQ), Kaiser Physical Activity Survey (KPAS), National Population Health Survey (NPHS), US National Health Interview Survey (US NHIS), Active People Survey, Health Survey for England Questionnaire, EPIC Physical Activity Questionnaire 2 (EPAQ2), and the Seven Day Recall Questionnaire.

3.8.6 Correlates measured

The included studies measured a range of personal, social, and environmental correlates (median 10.5; range 1 to 24). The most commonly reported personal correlates measured were age (23 studies), education (21 studies), marital status (12 studies), health (11 studies), overweight/obesity (11 studies), and socio-economic status (11 studies). The most common social correlates measured were self-efficacy (10 studies), barriers to regular physical activity (8 studies), and social support from friends (6 studies). The most common environmental correlates measured were access to places for exercise (9 studies), personal safety (6 studies), and rural location (6 studies). In total, 96 correlates were measured in the included studies (34 personal, 27 social, and 35 environmental correlates).

3.8.7 Outcomes

Overall, 73 correlates were found to be significantly associated with physical activity behaviour in at least one sub-group of the population, in one of more of the included studies.

3.8.7.1 Personal factors

The majority of studies (n=9) found no association between age and physical activity. Eight studies found age to be inversely associated with physical activity, while one study found a positive association between age and physical activity behaviour. Being male was positively associated with physical activity behaviour in six studies, and being overweight or obese was inversely associated with physical activity in seven studies.

Income, working part-time (as opposed to full-time work), home ownership, childcare availability, access to a bicycle, dog ownership, physical and mental health, postmenopausal status, and weight loss all tended to be positively associated with physical activity. Being married, having no children in the household, long-term illness, mobility limitations, pain limitations, injury from previous activity, and alcohol intake tended to be inversely associated with physical activity. There were mixed results for the association between physical activity behaviour and race/ethnicity, education, employment, occupational activity, number of adults in the household, and smoking status. There was no association between physical activity behaviour and deprivation, time at current address, number of sick days, fruit and vegetable consumption, time spent watching television, current pregnancy, and number of live births.

3.8.7.2 Social factors

Self-efficacy was found to be positively associated with physical activity behaviour in eight studies. Perceived social support tended to be positively associated with physical activity, although one study found there to be an inverse association between social support and physical activity. Social support from family and friends, and having friends to exercise with, tended to be positively associated with physical activity behaviour. Other factors found to be positively associated with physical activity included social roles, autonomous motivation, perceived behavioural control, physical activity identity, behavioural intentions, behavioural skills, perceived health benefits, and enjoyment of physical activity. Barriers to regular physical activity, and being able to find an exercise partner tended to be inversely associated with physical activity behaviour. There were mixed associations between physical activity behaviour and seeing others exercise, social norms, attending religious services, belonging to community groups, benefits of regular activity, knowing people who exercise, and having relatives to exercise with. No associations were found between physical activity and social cohesion, social issues, sense of community, outcome expectancies, and doing active social activities.

3.8.7.3 Environmental factors

Walking environment, personal safety in the neighbourhood, traffic, and having places within walking distance tended to be positively associated with physical activity behaviour. Additionally, the presence of pavements, and hills in the local environment were also positively associated with physical activity. Having access to a park, beach, river, gym/health club, walking/jogging trail, shops/shopping mall, and home exercise equipment tended to be positively

associated with physical activity behaviour. Perceived local environmental barriers, road safety for cyclists, and growing up in a city were all inversely associated with physical activity behaviour. There were mixed associations between percentage of green space, aesthetics, street lighting, land-use mix, access to places for exercise, and rural location with physical activity behaviour. There were no associations with physical activity behaviour for perceived community attributes, having an adequate number of parks, trails, or recreation areas in the local environment, knowing of jogging, walking, or cycling routes locally, and the presence of unattended dogs, or foul air from cars or factories. There were also no associations between physical activity and having access to golf courses, sports centres, swimming pools, tennis courts, indoor walking facilities, streets for exercise, or access to places for exercise via transportation.

3.9 Discussion

The results of the systematic review revealed a large number of correlates were associated with physical activity, in at least one sub-group of the population, and in one or more of the included studies. Across the studies, there were inconclusive associations with physical activity for many of the correlates. The high number of correlates, and inconclusive associations, means the results are difficult to interpret. This is especially true if the results are being used to guide the development of community-level physical activity interventions, because it would be difficult to select which correlates an intervention should be targeting. The correlates most consistently associated with physical activity behaviour were male gender, overweight/obesity (inversely), health, self-efficacy, social support, and barriers to regular activity (inversely). There were no consistent environmental correlates associated with

physical activity, suggesting this is an area that needs more investigating. These results also demonstrate that more research into all of the correlates of physical activity behaviour is still needed, in order to gain a better understanding of the association between physical activity and personal, social, and environmental correlates. More research will help identify the correlates that are consistently associated with physical activity in the entire population, as well as the correlates that are specific to certain sub-groups.

Only two of the included studies were from the United Kingdom, demonstrating a distinct lack of research into physical activity correlates from this country. Both of the studies from the United Kingdom investigated physical activity correlates from city populations. Additionally, only three of the twenty-eight studies reported being from rural settings, only one of which investigated physical activity behaviour in villages. These findings confirm that rural populations are understudied, not just for evaluations of community-level interventions, but also for studies of physical activity correlates. Due to limited comparable research being available from the United Kingdom, and from rural village communities, it will be difficult to interpret the findings from the Devon Active Villages evaluation study in relation to other studies.

Only one of the included studies measured physical activity behaviour longitudinally, over a period of fifteen years (Janssen et al., 2013). All of the other studies were cross-sectional, only measuring physical activity at one time point. The benefit of longitudinal observational studies is that they are able to identify factors that have a causal relationship with physical activity (physical activity determinants), rather than just associations (Bauman et al., 2012). It is longitudinal determinants that are able to predict change in physical activity (Van Stralen, de Vries, Muddle, Bolman, & Lechner, 2009). It is clear that more

studies investigating the longitudinal determinants of physical activity are needed. However, cross-sectional studies do allow multiple factors to be assessed at low cost, help prioritise population target groups, and provide evidence about potential mediators of physical activity for the development of interventions (Bauman et al., 2012).

Most of the studies incorporated random sampling into their design while four studies used convenience sampling. When participants are selected via convenience sampling, selection bias is an issue, which generally results in an over-sampling of healthy, physically active individuals, and may limit the generalisability of the findings to other populations (external validity). There was also a huge variation in sample size and characteristics between the included studies, ranging from 90 female participants aged 54-64 years in one study (Janssen et al., 2013), to 4,152 male and female participants aged 18-30 years in another study (Dowda et al., 2003), to 38,988 female participants aged 48-83 years in a third study (Orsini et al., 2007). It is extremely difficult to compare between studies when there are such large variations in sample size, gender breakdowns, and age ranges. Therefore, it was unsurprising that many of the correlates had inconclusive associations with physical activity.

Response rates varied considerably from 15.9% (Ogilvie et al., 2008) to 87.3% (Brownson et al., 2000; Wilcox et al., 2000). Response rates were likely to vary by survey measurement technique, for instance speaking to an interviewer on the telephone might be easier for some participants than completing a survey by hand, and returning it by mail. Similarly, asking participants to wear accelerometers may result in lower response rates, because of the added participant burden of wearing and returning the device. Research has found that response rates to postal surveys are improved when

incentives are offered, questionnaires are sent recorded delivery, with a stamped return envelope, using first class mailing, when there is pre-contact with participants, follow-up contact, when the study is university sponsored, and questionnaires are shorter, more interesting, more personalised, user friendly, and use coloured ink (Edwards et al., 2002). Estimating likely response rates are essential for estimating costs in survey studies. However, with such large differences in response rates being reported in the literature, accurate estimations of study costs may be difficult to calculate.

The studies reported a range of survey methods, from telephone and household interviews, to postal surveys, and surveys conducted at a test centre. Six studies measured physical activity behaviour using objective measures, such as accelerometers or pedometers. Objective measures have been found to provide more accurate estimations of physical activity energy expenditure, compared to self-reported surveys (Brage et al., 2003; Tudor-Locke et al., 2002). Therefore, care must be taken when interpreting the results from studies where physical activity was measured using surveys, in relation to studies where physical activity was measured objectively.

In a review of reviews of physical activity correlates and determinants, health status and self-efficacy were the clearest correlates and determinants of physical activity behaviour in adults (Bauman et al., 2012). This finding was replicated in our own review. The next clearest correlates and determinants from the Bauman et al. (2012) review were personal history of physical activity during adulthood and intentions to exercise. Personal history of physical activity was not reported in any of the included studies, while behavioural intentions were found to be positively associated with physical activity in two, out of two, studies. Additionally, age (inversely), male gender, education, ethnic origin,

overweight/obesity (inversely), perceived effort (inversely), and social support were reported correlates of physical activity, but were not determinants, in the Bauman et al. (2012) review. Evidence from the current review concurred with these findings for male gender, overweight/obesity, and social support, but the other factors provided inconclusive associations. Similar to the current review, findings were generally inconsistent across studies for the environmental correlates (Bauman et al., 2012).

3.9.1 Strengths and limitations of the review

This systematic review is up-to-date and includes the most recent studies of physical activity correlates. A large number of personal, social, and environmental correlates of physical activity behaviour were examined, from a wide range of settings and populations. Another strength of this review is the use of broad search terms in order to produce a relatively large number of initial database hits (n=693). By only searching the information included in the study title, the likelihood of finding all of the studies that fitted the inclusion criteria may have reduced. However, it is common practice for correlate research studies to include the term “correlate” and reference to physical activity in the study title. Additionally, in order to identify any additional studies that may have been missed by the initial search strategy, reference lists of the short-listed articles were searched.

The heterogeneous measures and findings in the review make it difficult to compare between studies, limiting the external validity, and highlighting the need for more focused research. The studies included in the review were limited to peer-reviewed published articles, which may be subject to publication bias. The short-listed studies were also limited to English peer-reviewed articles,

therefore, not all potentially relevant articles (e.g., non-English, dissertations) may have been included. Only studies from developed countries were included in the review, which limited the number of included studies, however, this did improve the generalisability of the findings. The review included studies from a fifteen-year period, so as to ensure the relevance of the included studies. However, such strict publication periods could be seen as somewhat arbitrary, and may have resulted in important studies being excluded. The usual procedure for systematic reviews involves at least two people reading through studies and checking abstraction forms. However, this review was conducted single-handed, and due to limited time and resources, only one database (Medline) was searched. As a result of this, suitable studies may not have been included, and errors may have been made. However, every effort was made to ensure the review was consistent with PRISMA guidelines, and objective throughout.

3.10 Conclusions

Numerous studies have investigated the correlates of physical activity behaviour in adults, however, there is still limited research available from rural populations in the United Kingdom. A large number of correlates were found to be associated with physical activity behaviour, in at least one sub-group of the population, and in one or more of the included studies. Across the studies, many correlates had inconclusive associations with physical activity behaviour, making it difficult to form clear recommendations for the development of effective tailored community-level physical activity interventions. The correlates that appeared to be most consistently associated with physical activity behaviour were male gender, overweight/obesity (inversely), health, self-

efficacy, social support, and barriers to regular activity (inversely). In order to better understand what factors are associated with physical activity, and ultimately design more effective interventions, more research is needed that investigates the correlates of physical activity behaviour, especially in rural populations from the United Kingdom.

In this chapter, I presented the findings of two systematic reviews I conducted: a systematic review of community-level physical activity interventions, and a systematic review of physical activity correlates. As well as presenting the findings, I described the methodology used to search the literature, shortlist the appropriate studies, and extract the necessary information. I also discussed the results of the reviews, and commented on the strengths and limitations of the included studies, and of the reviews themselves. In the next chapter, I propose the research design for the evaluation of the community-level physical activity intervention—‘Devon Active Villages’.

CHAPTER 4.

Research proposal

In the previous chapter, I discussed the results of two systematic reviews I conducted, examining community-level physical activity interventions, and the correlates of physical activity behaviour. In this chapter, I present the research proposal for the main study evaluating the Devon Active Villages community-level physical activity intervention. I also present a secondary research proposal for a cross-sectional study on the correlates of physical activity behaviour in rural adults. These research proposals are based on the findings from the literature reviews and systematic reviews presented in earlier chapters.

4.1 Evaluation of the Devon Active Villages physical activity intervention

Evidence on what makes some community-level interventions effective, and others not so effective, is currently limited (Baker et al., 2011). To meet the growing demand for accountability, funding agencies increasingly require large-scale quantitative evaluations of the impact of public health programmes (Habicht et al., 1999; House of Lords, 2011). Thus, more studies, especially rigorous evaluations of community-level physical activity interventions have been requested to further the theoretical understanding of what makes interventions successful (National Institute for Health and Clinical Excellence, 2008). Therefore, the aim of the main study was to rigorously evaluate the effectiveness of the Devon Active Villages community-level intervention, in regards to increasing physical activity prevalence levels.

Findings from the literature reviews and systematic reviews presented in earlier chapters were used to justify the proposed evaluation research design, in terms of the primary outcome, secondary outcomes, study design, physical activity measurement method, survey methods, and participants.

The Devon Active Villages intervention had already been planned and developed by Active Devon when the research study commenced. This meant that the research study had no control over the design or implementation of the intervention. Therefore, it was vital that the research study design was developed with the specific components of the Devon Active Villages intervention in mind. When developing the intervention, Active Devon had pre-selected the 155 rural communities that were due to receive the intervention (based on population size), however, Active Devon agreed to allow the research team to randomise the order in which the villages first received the intervention, thereby improving the strength of the study design.

4.1.1 Primary outcome

The primary outcome selected for the research study was physical activity, in regard to the proportion of participants that met the recommended physical activity guidelines (≥150 minutes of moderate-intensity activity or ≥75 minutes of vigorous-intensity physical activity per week; Department of Health, Physical Activity, Health Improvement and Protection, 2011). These guidelines were chosen, not only because they are the United Kingdom Government's minimum physical activity recommendations (Department of Health, Physical Activity, Health Improvement and Protection, 2011), but also because they are used to classify individuals in national surveys (e.g., Health Survey for England; Craig et al., 2009), and are internationally recognised among developed

countries (World Health Organization, 2010). In addition, the majority of studies examined in the systematic review of community-level physical activity interventions also classified participants by whether they met these physical activity recommendations. Therefore, by adopting these physical activity recommendations in the present study, our findings can be directly compared to national and international prevalence data, and the findings from community-level intervention studies from developed countries across the world.

4.1.2 Secondary outcomes

As well as the primary outcome, the study measured a range of secondary outcomes. One key secondary outcome was a continuous measure of physical activity (metabolic equivalent (MET) minutes per week). Most physical activity measurement methods measure physical activity on a continuous scale, and then use this data to classify participants by whether they met the physical activity recommendations or not. Although it is useful to understand physical activity levels in relation to the government recommended physical activity guidelines, the threshold level is somewhat arbitrary. Therefore, continuous measures of physical activity allow us to understand any changes that occur in physical activity behaviour, whether the changes are large or small, and above or below the threshold for meeting the activity recommendations.

Based on the notion that rural populations are generally understudied (Barnidge et al., 2013), it was important to measure a wide range of personal, social, and environmental factors, in order to gain an understanding of whether rural populations are unique in terms of the factors associated with physical activity. It was also important that these secondary outcomes fitted with Active Devon’s intervention objectives, including developing the sense of community,

developing strong, sustainable communities, improving health, and creating safer environments. Personal factors were selected based on measures used in previous studies, as examined in the systematic review of physical activity correlates (e.g., gender, age, height, weight, education, employment, health, dog ownership, and cars in the household). Social factors were also selected using findings from the systematic review of physical activity correlates, including intention to exercise, history of physical activity (habits), physical activity confidence, and social norms. Based on Active Devon's objective to improve the sense of community in the intervention villages, 'village supportiveness of physical activity' was also measured. From the research available on rural communities from the United States, lack of access to recreational facilities and equipment for exercise is a recurrent theme (Murimi & Harpel, 2010; Parks et al., 2003; Wilcox et al., 2000). Therefore, measuring access to recreational facilities in the present study would be helpful to assess whether this is also a barrier to physical activity for rural adults from the United Kingdom. Perceived community attributes (e.g., safety, aesthetics), recent use of recreational facilities, and locality of recreational facilities used were also investigated.

4.1.3 Study design

Research has called for novel approaches for the evaluation of public health interventions (Hills, 2004; House of Lords, 2011). Bearing this in mind, along with the specific components of the Devon Active Villages intervention, and the information presented in the review of study methodologies, the stepped wedge cluster randomised controlled trial appears to be the most suitable study design. The Devon Active Villages intervention was by necessity

delivered in waves, with multiple village communities receiving the intervention at each wave. Once the initial twelve-week intervention period ended, the village communities were encouraged to independently sustain the intervention activities, and so the intervention was effectively never withdrawn. On this basis, the stepped wedge cluster randomised trial design was the study design selected to evaluate the effectiveness of the Devon Active Villages intervention. To the best of our knowledge, this is the first evaluation of a community-level physical activity intervention to use a stepped wedge cluster randomised controlled trial.

4.1.4 Physical activity measurement

From the review of physical activity measurement techniques presented earlier, there are a number of different measurement tools available for measuring physical activity, varying in ease of assessment, cost, and precision. For the evaluation study, there was very limited funding available for research costs, with only a single researcher (myself) available to complete the data collection, entry, and data cleaning. The study also needed to involve low participant burden, because there was no budget available to offer participants an incentive for participating. Participants needed to be measured from across Devon, therefore, measurement techniques that did not require them to visit the University of Exeter were preferred. Therefore, self-reported measures were deemed the most appropriate for this particular evaluation study, because objective measures would have been too costly and time-consuming to complete on such a large scale with limited resources. Due to the complex and time-consuming data processing involved with activity diaries (or logs), and the limited researcher time available in this study, questionnaires were chosen as

the most suitable measure for the Devon Active Villages evaluation study. The questionnaires were administered to participants via postal surveys. This method was selected because it is relatively cheap and less time-consuming to conduct. Money was available in the research budget to cover printing, postage, and return address envelopes. Household or telephone interviews were rejected because they require large amounts of researcher time, too much for a single researcher to deal with in a study of this magnitude.

4.1.5 Participants

The Devon Active Villages intervention was aimed at people of all ages, including both children and adults. Child and youth physical activity comprises a separate body of literature, and is often harder to measure because of their sporadic activity incorporated as ‘play’ (Trost, 2007). Additionally, not all questionnaires are suitable for young children, due to cognitive immaturity, and so any questionnaire used in the study would need to be adapted to be suitable for completion by children (Sallis, 1991). Due to these reasons, it was decided that this evaluation study would only focus on adults (aged 18 years and over) from the intervention villages.

4.2 Cross-sectional study of physical activity correlates

The systematic review of physical activity correlates presented earlier demonstrated the lack of research available from adult populations in rural settings, especially from the United Kingdom. Thus, the stepped wedge cluster randomised controlled trial provided an ideal opportunity to add to the existing literature by examining the baseline data as a cross-sectional study of physical activity correlates in rural adults. The primary outcome, secondary outcomes,

physical activity measurement, and participants were the same for the cross-sectional study, because they were derived from the baseline data for the main stepped wedge cluster randomised controlled trial study.

4.3 Conclusions

This chapter has presented the justification for study design chosen to evaluate the Devon Active Villages intervention. The main evaluation will take the form of a stepped wedge cluster randomised controlled trial, using a postal survey study to assess the proportion of adults who report meeting the recommended physical activity guidelines, and a range of secondary outcomes. The main study methods, results, and discussion will be presented in Chapter 6. The study protocol for the main evaluation study has been written-up and published in BMC Public Health (Appendix G). In the next chapter, I present the cross-sectional study of physical activity correlates, describing the methods used to collect and analyse the data, and discussing the results in relation to the findings from other studies of physical activity correlates.

CHAPTER 5.
Cross-sectional study of physical activity correlates

In the previous chapter I presented the research proposal for two studies. The main study evaluates the Devon Active Villages community-level physical activity intervention (Chapter 6). In this chapter, I describe the aims of the cross-sectional study of physical activity correlates, as well as the methods used to collect and analyse the data. I then present the main findings from this study, discuss these findings in relation to the findings from other studies, and comment on the study's own strengths and limitations.

5.1 Aims of the study

The main aim of the cross-sectional study was to identify the correlates of physical activity behaviour in adults residing in rural villages in south-west England. This study utilised baseline data collected from the stepped wedge cluster randomised controlled trial, which proved an excellent opportunity to obtain a representative random sample of rural adults from village communities across Devon, south-west England.

The association of demographic, psycho-social, perceived environmental, and village-level factors with self-reported physical activity outcomes was examined. It is important to understand the various factors that affect physical activity behaviour, so that future physical activity interventions can be designed to specifically target these behaviours. It is, therefore, also important to understand the differences between rural and urban adults in terms of their

physical activity behaviour, so that future interventions can be tailored appropriately to be effective for a particular community type.

5.2 Methods

This study uses baseline data from the first time period of the stepped wedge cluster randomised controlled trial evaluating the effectiveness of the Devon Active Villages physical activity intervention. Ethical approval for the study was obtained from University of Exeter Sport and Health Sciences Ethics Committee (Appendix H).

5.2.1 Recruitment and participants

The study was conducted in 128 rural villages across Devon, south-west England, each with a population size between 500 and 2000 people. These criteria were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities they offered. The addresses of all households in Devon were purchased from a private company (Address List Utility, Arc en Ciel, Version 3.1 PAF Quarter 1, 2011) and used to generate a complete list of all households within the study villages. From the list, a random sample of households, stratified by village, was selected to receive a survey questionnaire via the post. Households were sent a questionnaire, a participant information sheet, and a prepaid return envelope. The adult in each household who had most recently had a birthday was invited to complete the survey. Eligible participants were aged 18 years or over and resident in the household.

The survey consisted of 28 questions and took participants approximately 10-15 minutes to complete, based on estimates obtained during

pilot work. Informed consent was implied when participants returned a completed questionnaire. In total, 2,415 adults aged 18 to 102 years returned a questionnaire and formed the sample for the study.

5.2.2 Measures

Examples of the complete survey and participant information sheet can be found in Appendices I and J, respectively.

5.2.2.1 Physical activity

Physical activity was measured using the self-administered, short version of the International Physical Activity Questionnaire (IPAQ-SV; Craig et al., 2003). The IPAQ-SV includes seven items collecting information on the frequency and duration of physical activities undertaken in the previous seven days (vigorous-intensity activity, moderate-intensity activity, walking, and sitting behaviour). The IPAQ-SV has been rigorously tested for reliability and validity (Craig et al., 2003; Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012; Lee, Macfarlane, Lam, & Stewart, 2011).

Participants were categorised according to whether they did sufficient physical activity to meet the current United Kingdom physical activity guidelines (at least 150 minutes of moderate-to-vigorous-intensity activity per week in bouts of 10 minutes or more, or at least 75 minutes of vigorous-intensity activity per week: Department of Health, Physical Activity, Health Improvement and Protection, 2011). Physical activity level was also analysed using metabolic equivalent (MET) values to calculate participants' total MET-minutes per week of moderate-intensity walking, moderate-intensity physical activity, and vigorous-intensity physical activity, using the IPAQ-SV scoring methods for

calculating physical activity levels (International Physical Activity Questionnaire, 2005).

5.2.2.2 Demographic characteristics

Participants were asked to report their gender, age, health status, dog ownership, number of children, and cars in the household. These were based on questions from the Health Survey for England (Craig et al., 2009), apart from the dog ownership question that was taken from an Australian cohort study (Burton, Oldenburg, Sallis, & Turrell, 2007). Body mass index (BMI), defined as weight (kg) divided by height squared (m^2), was calculated from participants' self-reported height and weight.

5.2.2.3 Psychosocial factors

To assess psychosocial factors, measures were created based on a multi-national motivation for change scale (Miller & Johnson, 2008), and a scale developed for use in an Australian cohort study (Burton et al., 2007; Table 5-1). Any negatively worded items were recoded so that higher scores were positive. For the 'commitment to doing more physical activity' variable, the mean was calculated across the three constituent items, and the resulting variable was categorised based on the tertiles (low, moderate, and high). The mean scores were calculated from the constituent items for the 'physical activity social norms', 'physical activity habit', and 'physical activity village supportiveness' variables, and then categorised into "Unfavourable" (<0), "Neutral" (0), and "Favourable" (>0).

5.2.2.4 Perceived local environmental characteristics

Perceived local environmental characteristics were measured using items previously developed for use in a United Kingdom health study, and found to have acceptable levels of test-retest reliability (ICC: 0.73; Ogilvie et al., 2008; Table 5-1). Perceived proximity and use of different recreational facilities were measured in the survey using scales that were previously found to have acceptable test-retest reliability (Burton et al., 2007; Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997; Table 5-1). The means were calculated from the constituent items for the variables measuring ‘traffic and pleasantness of surroundings’, ‘proximity and convenience of walking’, ‘safety and convenience of cycling’, ‘convenience of public transport’, and ‘safety of walking after dark’, and were then categorised into “Unfavourable” (<0), “Neutral” (0), and “Favourable” (>0).

Table 5-1 Survey measures

Psychosocial factors

Commitment to doing more physical activity (3 items—rated from 0 “not at all” to 10 “very much so”; Miller & Johnson, 2008)

How important is it for you to do more physical activity than you do now?
How confident are you that you could do more physical activity if you decided to?
To what extent are you trying to do more physical activity?

Physical activity social norms (2 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Burton et al., 2007)

My family is interested in physical activity/sport
People around my village all seem to be exercising these days

Physical activity habit (3 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Burton et al., 2007)

I find it easy to have a go at physical activities
I have always done some kind of physical activity
In the last 2 years, I have been involved in regular physical activity at one time or another

Physical activity village supportiveness (3 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Burton et al., 2007)

I have recently had opportunities to get involved in physical activity
My village is a good place to be physically active
There are very few opportunities to be physically active in my village

Perceived local environmental characteristics

Perceptions of the local area (5 factors)

Traffic and pleasantness of surroundings (4 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Ogilvie et al., 2008)

It is pleasant to walk in the local area
There is a lot of traffic noise in the local area
There is little traffic in the local area
It is safe to cross the road in the local area

Proximity and convenience of walking (4 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Ogilvie et al., 2008)

There is a park within walking distance
The nearest shops are too far to walk to
There are no convenient routes for walking in the local area
There are no pavements in the local area

Safety and convenience of cycling (2 items—rated from -2 “strongly disagree” to +2 “strongly agree”; Ogilvie et al., 2008)

The roads are dangerous for cyclists in the local area
There are convenient routes for cycling in the local area

Convenience of public transport (1 item—rated from -2 “strongly disagree” to +2 “strongly agree”; Ogilvie et al., 2008)

Safety of walking after dark (1 item—rated from -2 “strongly disagree” to +2 “strongly agree”; Ogilvie et al., 2008)

Presence of recreational facilities within the local area (3 factors)

Manmade sports facilities in local area (4 items—responses 1 “yes” versus 2 “no”; Burton et al., 2007)

Sporting club/recreation centre/gym
Public swimming pool
Public tennis/squash courts
Indoor sports facilities (e.g., sports hall)

Table 5-1 (continued)

Natural activity facilities in local area (3 items—responses 1 “yes” versus 2 “no”; Burton et al., 2007)
Walking routes/footpaths
Local park/public green space
River/beach/waterfront
Community centre/village hall in local area (1 item—responses 1 “yes” versus 2 “no”; Burton et al., 2007)
Use of recreational facilities (8 items—responses 0 “no, not in the last year”, 1 “yes, in last 12 months” or 2 “yes, in last month”; Sallis et al., 1997)
Walking routes/footpaths
Local park/public green space
Sporting club/recreation centre/gym
River/beach/waterfront
Public swimming pool
Public tennis/squash courts
Indoor sports facility (e.g., sports hall)
Community centre/village hall
Locality of facilities used (8 items—response box for participant to name location of facility used; Sallis et al., 1997)
Walking routes/footpaths
Local park/public green space
Sporting club/recreation centre/gym
River/beach/waterfront
Public swimming pool
Public tennis/squash courts
Indoor sports facility (e.g., sports hall)
Community centre/village hall

5.2.2.5 Village-level factors

Five village-level factors were examined: population density (Office for National Statistics, 2001; retrieved from http://www.ons.gov.uk/ons/guide-method/census/2011/index.html), mean age of villagers (Devon County Council, retrieved from http://www.devon.gov.uk/), percent of villagers that were male (Office for National Statistics, 2001), Indices of Multiple Deprivation (higher scores indicates more deprived; English Indices of Deprivation, retrieved from https://www.gov.uk/government/publications/english-indices-of-deprivation-2010), and the dominant Sport England Market Segmentation for each village (Sport England, retrieved from http://www.sportengland.org/research/market_segmentation.aspx). The Sport England Market Segmentation divides the

English adult population into 19 market segments based on their sports participation, motivations, and barriers to doing more sport, allowing Local Authorities, Sport National Governing Bodies, and sports clubs to profile both individuals and areas.

5.2.3 Sample size

Power calculations were based on the stepped wedge cluster randomised controlled trial study protocol. It was estimated that 10 participants would need to be recruited from each of the 128 villages at each stage of the stepped wedge trial, in order to achieve 80% power at the 5% significance level, based on detecting an increase from 25% to 30% in the proportion of participants that met the recommended activity guidelines (Hussey & Hughes, 2007). A recent pilot for a population study of travel behaviour in the United Kingdom achieved a response rate of approximately 20% for a short questionnaire postal survey (Sahlqvist et al., 2011). Using this as a guide, 50 surveys were sent out to each of the 128 villages, anticipating that we would obtain at least 10 responses per village. If the number of completed questionnaires returned within three weeks of the initial mailing was insufficient for a given village, additional questionnaires were sent out to new households.

5.2.4 Statistical analysis

Dr Obioha Ukoumunne (University of Exeter Medical School) and Dr Brad Metcalf (Sport and Health Sciences, University of Exeter) assisted the research project with the study design, power calculations and statistical analysis. Following data collection and entry, the data was cleaned for missing and out-of-range values. A random sample of 10% of the surveys were double entered

to check for data entry errors. All analyses were carried out using Stata 12.1 software (StataCorp, 2011).

Random effects ("multilevel") logistic regression was used to examine whether the personal, social, environmental, and village-level factors predict whether participants meet the recommended physical activity guidelines (binary outcome). Random effects linear regression was used to study the relationship of the same factors with MET-minutes of moderate-vigorous physical activity per week (continuous outcome). These methods take account for correlation (clustering) between responses of participants in the same village. Firstly, crude (unadjusted) models were fitted separately for each factor as the sole predictor in the analysis. Partially adjusted models were then fitted for each type of factor, using as predictors those that were significant at the 5% level in the unadjusted analyses (e.g., a model was fitted with significant personal factors only). Finally, a single fully adjusted model was fitted including all factors of all types that were significant predictors in the partially adjusted models. The tabulated findings are based on analyses of males and females together. Tests of interaction were carried out to assess evidence of differential effects between the gender groups and where found these are commented on in the text.

5.3 Results

Initially, 6,400 surveys were sent out, with an additional 10 surveys sent out after three weeks because two villages had not achieved their quota of 10 completed responses. The median number of completed responses per village was 18 (range 11 to 31). 2,415 responses were received in total, achieving a response rate of 37.7%.

5.3.1 Descriptive characteristics

The majority of respondents were female (62.7%), with a mean (SD) age of 58 years (15.2; range 18 to 102). Half of the participants (49.4%) were classified as either overweight or obese. 66.9% of all respondents reported doing sufficient physical activity to meet the recommended guidelines, reporting a median (interquartile range) total MET-minutes physical activity a week of 1,638 (0 to 3879; Table 5-2).

The mean (SD) time participants had spent living in the local area was 18.5 years (17.3, range 1 month to 91 years). 59.8% of participants had a positive view of their local area. Walking routes/footpaths, community centres/village halls, and local parks/public green space were the most commonly reported facilities within walking distance or a short drive (within three miles) of where participants lived (Figure 5-3). This definition of the local area was based on a validated measure (Burton et al., 2007), however, one study reported that adults generally considered their walkable neighbourhood to be less than one mile, and that the interpretation of their neighbourhood area does not appear to relate accurately to the definitions typically used in research (Smith, Gidlow, Davey, & Foster, 2010). Indoor sports facilities and public swimming pools were the least reported facilities in the local area. Within the last month, participants had most commonly reported using walking routes/footpaths, rivers/beaches/waterfronts, local parks/public green space, and community centres/village halls (Figure 5-4). Whereas, some facilities were mostly used in the local area (e.g., walking routes/footpaths and community centres/village halls), most participants reported using rivers/beaches/waterfronts outside of their local area (Figure 5-4). Similar

patterns were seen for the use of recreational facilities within the last year (Figure 5-5).

Compared to the general population of the study villages, the study participants tended to be older (70.2% versus 59.2% aged 50 years or over), and a greater proportion were female (62.7% versus 51%). The study participants were equivalent to the general village population in terms of their Index of Multiple Deprivation scores (mean (SD) 15.8 (4.0) for both populations). The study participants were also extremely similar to the general population in terms of the population density of the village they resided within (mean (SD) 0.62 (0.5) for the study population versus 0.64 (0.6) for the village population).

Table 5-2 Descriptive characteristics of study participants (N=2415)

Factors	*%*
Personal Factors	
Males	37.3
Age, y	
18-34	6.8
35-49	23.5
50-64	35.7
65+	34.5
BMI, kg/m2	
Normal weight (18-25)	50.6
Overweight (25-29.99)	35.6
Obese (≥30)	13.8
Health	
Poor/Fair	17.9
Good	33.9
Very Good/Excellent	48.2
Participants with a long-term illness or disability	28.7
Full-time education leaving age, y	
16 & Under	37.6
17-18	25.8
19+	36.6
Occupational activity	
Not employed	49.8
Sedentary/Standing job	36.1
Physical job	14.2
Cars in household	
No cars	3.9
1 car	38.5
2 or more cars	57.5
Households with children U15	21.5
Households with dogs	39.2
Social Factors	
Commitment to doing more PA (tertiles)	
Low	35.9
Moderate	34.1
High	30.1
Social Norms	
Unfavourable	27.5
Neutral	23.4
Favourable	49.1
Habit	
Unfavourable	23.8
Neutral	8.5
Favourable	67.7
Village Supportiveness	
Unfavourable	49.2
Neutral	22.8
Favourable	28.1

Table 5-2 (continued)

Factors	*%*
Environmental Factors	
Traffic and pleasantness of surroundings	
Unfavourable	12.6
Neutral	12.3
Favourable	75.2
Proximity and convenience of walking	
Unfavourable	37.2
Neutral	15.7
Favourable	47.1
Safety and convenience of cycling	
Unfavourable	32.8
Neutral	36.9
Favourable	30.3
Convenience of public transport	
Unfavourable	59.0
Neutral	13.9
Favourable	27.2
Safety walking after dark	
Unfavourable	26.2
Neutral	16.0
Favourable	57.8
At least one manmade sports facility in local area	61.3
At least one natural activity facility in the local area	97.3
Community centre/village hall in local area	79.1
Use of recreational facilities	
No facilities used	6.5
Used in last year only	9.5
Used in last month	84.0
Locality of facilities used	
No facilities used	15.2
Local village only	24.2
Outside local village only	13.7
Both local and not local	46.9
Village Level Predictors	
Population density (residents per hectare), mean (SD)	0.6 (0.5)
Age, mean (SD)	45.8 (3.3)
% males in village (tertiles)	
Low	35.6
Moderate	32.1
High	32.4
Indices of Multiple Deprivation (IMD)	
More deprived than median score for villages in Devon	49.6

Table 5-2 (continued)

Factors	*%*
Sport England Segmentation	
3 (Chloe)	6.9
6 (Tim)	48.8
8 (Jackie)	0.5
11 (Philip)	2.0
13 (Roger & Joy)	10.3
17 (Ralph & Phyllis)	27.2
19 (Elsie & Arnold)	4.3
Physical Activity	
Meets recommended guidelines	66.9
MET-minutes/week (total LTPA), median (IQR)	1638 (0 to 3879)

Sample sizes ranged from 2336 to 2415.

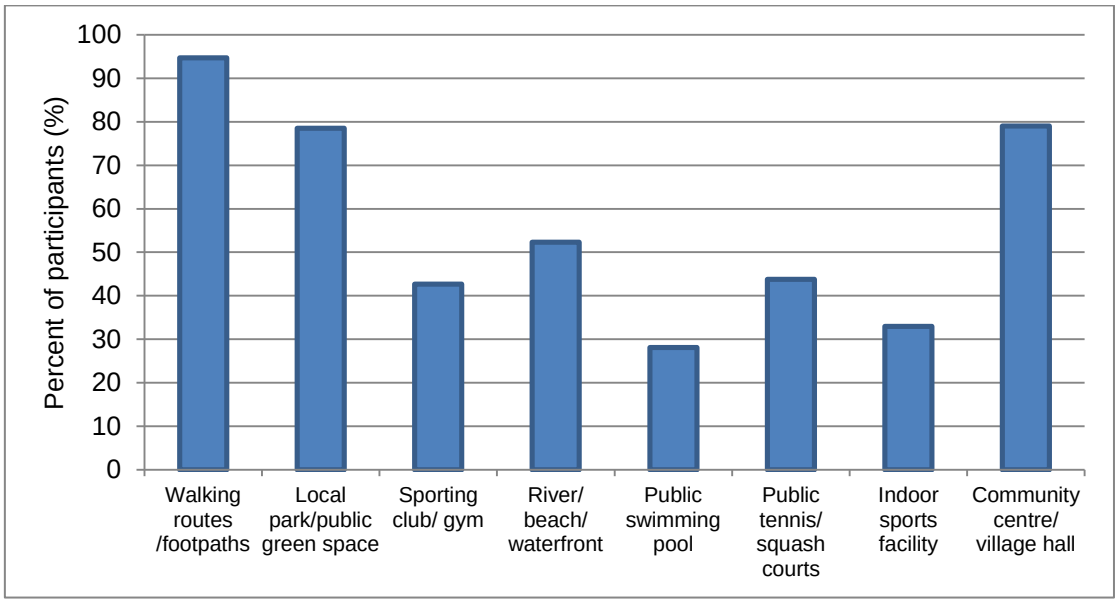


Figure 5-3 Facilities within walking distance or a short drive (within 3 miles) from where participants lived.

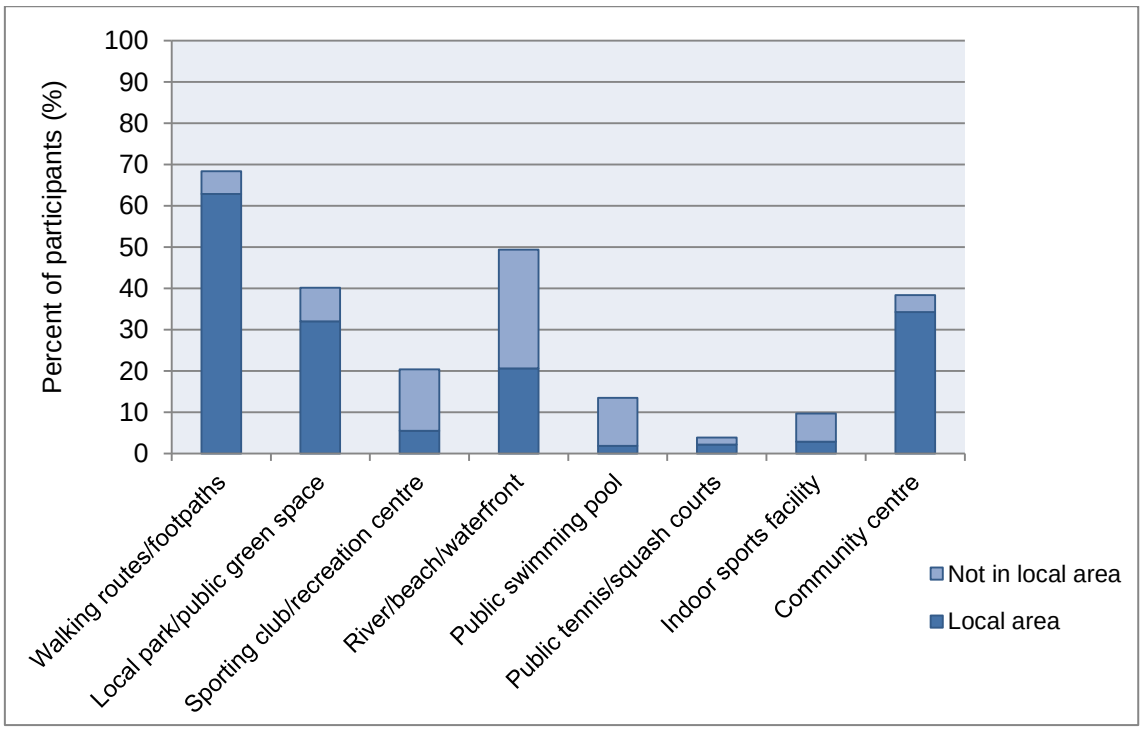


Figure 5-4 Use of recreational facilities in the last month (within and outside of the local area).

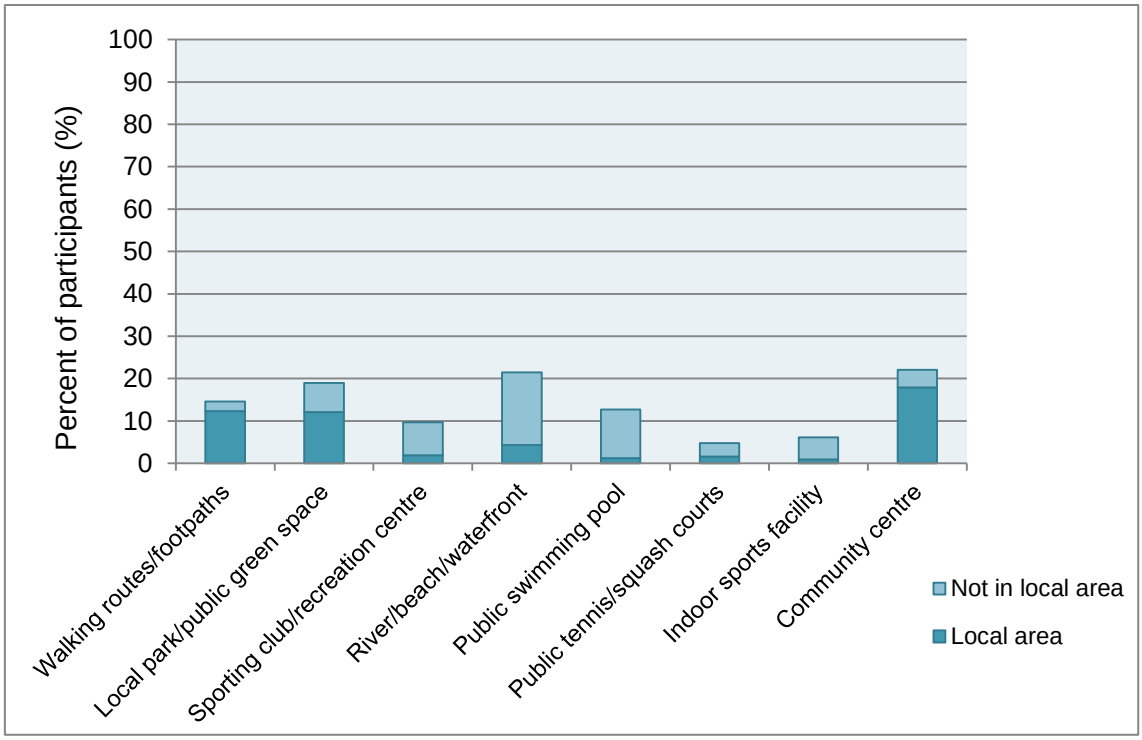


Figure 5-5 Use of recreational facilities in the last year (within and outside of the local area).

5.3.2 Factor analysis

The dimensionality of the scales measuring ‘perceptions of the local area’ (Ogilvie et al., 2008), and the ‘presence of recreational facilities within the local area’ (Burton et al., 2007) was examined using exploratory factor analysis (with principal component factors) with a varimax (orthogonal) rotation. Factor analysis examines whether the variation in the observed variables can be explained largely by a smaller number of underlying factors. The Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett’s test of sphericity were conducted to confirm the data’s suitability for factor analysis.

For the scale measuring perceived environmental characteristics the scree plot indicated there were three factors (Figure 5-6) “Traffic and pleasantness of surroundings”, “Proximity and convenience of walking”, and “Safety and convenience of cycling”. Two original scale items (“Convenience of public transport” and “Safety of walking after dark”) were not strongly correlated with any of the factors (factor loadings <0.5) and so were treated as separate variables. Two factors were indicated for the scale measuring availability of recreational facilities in the local area (Figure 5-7). These were “Manmade sports facilities in local area” and “Natural activity facilities in local area”. The item “Community centre/village hall in local area” was treated as a separate variable, because the factor loading was less than 0.5. Composite scores were created for each of the factors, based on the mean of the items that had their primary loadings on each factor. To measure internal consistency Cronbach’s alpha was calculated for each subscale, and pairwise correlation coefficients tested the collinearity between the subscales.

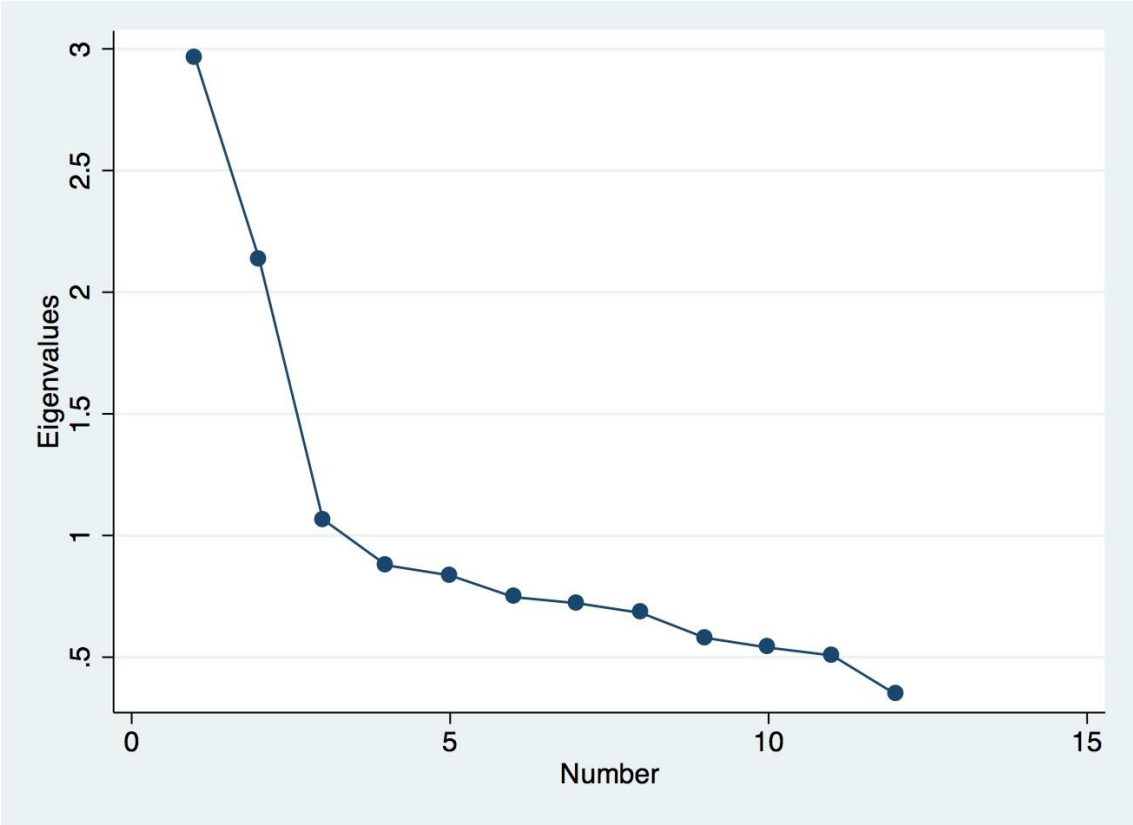


Figure 5-6 Scree plot for ‘Perceived environmental characteristics’ scale

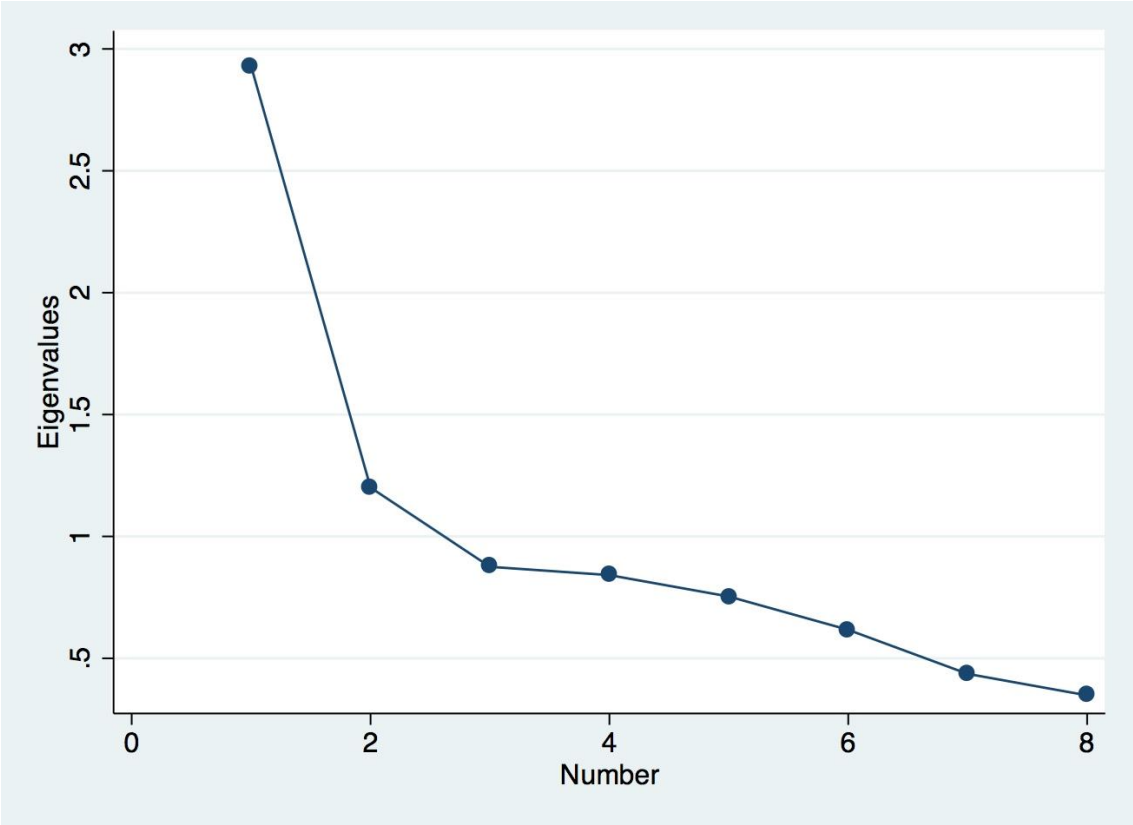


Figure 5-7 Scree plot for ‘Availability of recreational facilities’ scale

5.3.3 Meets recommended activity guidelines

5.3.3.1 Personal factors

The logistic regression analyses (Table 5-8) revealed that being male and in better health were positively associated with the odds of meeting the recommended activity guideline in the fully adjusted models. Not having a long-term illness or disability, education leaving age, number of cars in the household, and dog ownership were positively associated to meeting physical activity guidelines in the unadjusted and partially adjusted regression models, but not the fully adjusted models. Occupational activity and having children in the household were positively associated to activity behaviour in the unadjusted model, but not the partially adjusted model. Age and BMI were negatively associated with the likelihood of meeting the activity guidelines, but only in the unadjusted model.

5.3.3.2 Social factors

Greater commitment to doing more physical activity, favourable activity social norms and a greater physical activity habit were associated with increased odds of being active at recommended levels in the fully adjusted model. Village supportiveness of physical activity was positively associated to meeting the recommended guidelines in the unadjusted model, but was no longer significant in the partially adjusted model.

5.3.3.3 Environmental factors

Recent use of recreational facilities was positively associated to likelihood of meeting the guidelines in the fully adjusted model. Locality of facilities used

was positively associated with activity behaviour in the unadjusted and partially adjusted models, but not in the fully adjusted model. ‘Traffic and pleasantness of surroundings’, ‘safety of walking after dark’, as well as the locality of manmade sports facilities, natural activity facilities and a community centre were all positively associated to meeting the guidelines in the unadjusted model, but not in the partially adjusted model. ‘Convenience of public transport’ was found to be negatively associated with the likelihood of meeting the guidelines in the partially adjusted model, but not in the fully adjusted model. ‘Proximity and convenience of walking’, and the ‘safety and convenience of cycling’ were found to have no relationship with physical activity behaviour.

5.3.3.4 Gender interactions

‘Commitment to doing more physical activity’ was the only variable found to have a significant interaction with gender (p-value for interaction = 0.043). There was little evidence of an association between commitment to doing more physical activity and meeting the recommended activity guideline for females (p=0.19). Males, however, with ‘moderate’ (adjusted OR 1.52, 95% CI: 1.03 to 2.24) or ‘high’ (adjusted OR 2.64, 95% CI: 1.59 to 4.38) commitment levels, had increased odds of meeting the guidelines, compared to those with ‘low’ commitment levels (p<0.001).

Table 5-8 Odds ratios for meeting physical activity guidelines—logistic regression

	Unadjusted			*Partially adjusted*			*Fully adjusted*		
Predictor Variable	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*
Personal factors									
Gender			0.03			<0.001			0.002
Male		Reference			Reference			Reference	
Female	0.82	0.69 to 0.98		0.69	0.56 to 0.85		0.70	0.55 to 0.88	
Age Groups (years)			<0.001			0.03			0.54
18-34		Reference			Reference			Reference	
35-49	0.87	0.57 to 1.33		1.10	0.70 to 1.73		0.99	0.61 to 1.61	
50-64	0.70	0.47 to 1.04		1.00	0.64 to 1.57		0.99	0.62 to 1.58	
65+	0.32	0.21 to 0.48		0.69	0.42 to 1.13		0.82	0.50 to 1.35	
BMI Category			<0.001			0.04			0.40
Normal weight		Reference			Reference			Reference	
Overweight	0.79	0.65 to 0.96		0.84	0.68 to 1.04		0.93	0.74 to 1.18	
Obese	0.47	0.37 to 0.60		0.71	0.54 to 0.94		0.81	0.59 to 1.10	
Health			<0.001			<0.001			<0.001
Poor/Fair		Reference			Reference			Reference	
Good	2.83	2.23 to 3.61		1.98	1.49 to 2.63		1.57	1.14 to 2.17	
Very good/Excellent	5.92	4.66 to 7.53		3.34	2.44 to 4.56		2.05	1.44 to 2.91	
Long-term Illness/Disability			<0.001			0.01			0.06
Yes		Reference			Reference			Reference	
No	3.27	2.71 to 3.94		1.38	1.07 to 1.77		1.31	0.99 to 1.73	
Education leaving age (years)			<0.001			0.04			0.98
16 & under		Reference			Reference			Reference	
17-18	1.58	1.27 to 1.96		1.27	0.99 to 1.61		1.02	0.78 to 1.34	
19+	1.86	1.52 to 2.28		1.32	1.05 to 1.66		1.00	0.77 to 1.28	

Table 5-8 (continued)

Predictor Variable	*OR*	*Unadjusted 95% CI*	*p*	*OR*	*Partially adjusted 95% CI*	*p*	*OR*	*Fully adjusted 95% CI*	*p*
Occupation Category			<0.001			0.23			
Not employed		Reference			Reference				
Sitting/standing job	1.82	1.51 to 2.20		0.97	0.75 to 1.26				
Physical job	2.41	1.82 to 3.20		1.28	0.91 to 1.80				
Cars in Household			<0.001			0.007			0.22
No car		Reference			Reference			Reference	
1 car	4.11	2.55 to 6.62		2.08	1.20 to 3.61		1.38	0.71 to 2.66	
2+ cars	7.74	4.82 to 12.43		2.43	1.38 to 4.26		1.61	0.82 to 3.17	
Children Under15 in Household			<0.001			0.75			
Yes		Reference			Reference				
No	0.58	0.47 to 0.73		1.05	0.77 to 1.44				
Dog Ownership			<0.001			0.047			0.15
Yes		Reference			Reference			Reference	
No	0.71	0.60 to 0.85		0.81	0.67 to 1.00		0.85	0.68 to 1.06	
Social factors									
Commitment to doing more PA			<0.001			<0.001			0.002
Low		Reference			Reference			Reference	
Moderate	1.63	1.33 to 1.99		1.43	1.14 to 1.79		1.21	0.94 to 1.55	
High	2.79	2.22 to 3.50		1.98	1.54 to 2.55		1.66	1.25 to 2.20	
Social Norms			<0.001			0.003			0.004
Unfavourable		Reference			Reference			Reference	
Neutral	1.43	1.13 to 1.80		0.95	0.73 to 1.24		1.05	0.79 to 1.40	
Favourable	2.53	2.06 to 3.11		1.39	1.09 to 1.77		1.47	1.14 to 1.90	
Habit			<0.001			<0.001			<0.001
Unfavourable		Reference			Reference			Reference	
Neutral	2.17	1.57 to 3.02		1.89	1.35 to 2.65		1.61	1.12 to 2.33	
Favourable	7.77	6.27 to 9.62		6.24	4.96 to 7.86		4.30	3.33 to 5.55	

Table 5-8 (continued)

Predictor Variable	*OR*	*Unadjusted 95% CI*	*p*	*OR*	*Partially adjusted 95% CI*	*p*	*OR*	*Fully adjusted 95% CI*	*p*
Village Supportiveness			<0.001			0.13			
Unfavourable		Reference			Reference				
Neutral	1.66	1.33 to 2.07		1.30	1.01 to 1.67				
Favourable	1.95	1.57 to 2.41		1.12	0.87 to 1.43				
Environmental factors									
Traffic and pleasantness of surroundings			0.04			0.74			
Unfavourable		Reference			Reference				
Neutral	1.15	0.83 to 1.62		1.03	0.72 to 1.47				
Favourable	1.37	1.06 to 1.76		1.10	0.83 to 1.46				
Proximity and convenience of walking			0.30			0.53			
Unfavourable		Reference			Reference				
Neutral	1.17	0.90 to 1.53		1.17	0.88 to 1.54				
Favourable	0.96	0.80 to 1.16		1.02	0.83 to 1.25				
Safety and convenience of cycling			0.96			0.87			
Unfavourable		Reference			Reference				
Neutral	1.02	0.83 to 1.25		1.04	0.83 to 1.29				
Favourable	0.98	0.79 to 1.22		0.98	0.77 to 1.23				
Convenience of public transport			0.18			0.04			0.64
Unfavourable		Reference			Reference			Reference	
Neutral	0.94	0.73 to 1.21		0.85	0.65 to 1.12		0.93	0.68 to 1.27	
Favourable	0.83	0.68 to 1.01		0.76	0.62 to 0.95		0.89	0.70 to 1.14	
Safety walking after dark			0.002			0.07			
Unfavourable		Reference			Reference				
Neutral	0.97	0.75 to 1.27		0.96	0.72 to 1.27				
Favourable	1.36	1.11 to 1.66		1.23	0.98 to 1.53				

Table 5-8 (continued)

Predictor Variable	OR	Unadjusted 95% CI	p	OR	Partially adjusted 95% CI	p	OR	Fully adjusted 95% CI	p
Manmade sports facilities in local area			<0.001			0.09			
1+ facility		Reference			Reference				
No facilities	0.72	0.60 to 0.85		0.84	0.69 to 1.03				
Natural activity facilities in the local area			<0.001			0.26			
1+ facility		Reference			Reference				
No facilities	0.35	0.22 to 0.58		0.72	0.41 to 1.27				
Community centre in local area			<0.001			0.05			
Yes		Reference			Reference				
No	0.66	0.54 to 0.82		0.79	0.63 to 1.00				
Use of recreational facilities			<0.001			<0.001			0.01
No facilities used		Reference			Reference			Reference	
Used in last year only	1.70	1.12 to 2.58		1.69	1.00 to 2.86		1.31	0.70 to 2.44	
Used in last month	4.49	3.19 to 6.33		4.09	2.52 to 6.63		2.04	1.10 to 3.47	
Locality of facilities used			<0.001			<0.001			0.27
No facilities used		Reference			Reference			Reference	
Local village only	1.32	1.01 to 1.72		0.69	0.49 to 0.98		0.73	0.48 to 1.11	
Outside local village	2.28	1.66 to 3.12		1.39	0.93 to 2.07		0.97	0.61 to 1.54	
Local and not local	2.31	1.81 to 2.94		1.07	0.77 to 1.51		0.88	0.59 to 1.31	
Village-level factors									
Population density	1.07	0.92 to 1.27	0.36	1.06	0.88 to 1.27	0.56			
Mean age	1.01	0.99 to 1.04	0.27	0.99	0.96 to 1.03	0.71			
Gender (% males)			0.18			0.15			
Low		Reference			Reference				
Moderate	1.14	0.93 to 1.41		1.17	0.94 to 1.45				
High	0.94	0.77 to 1.15		0.95	0.76 to 1.18				

Table 5-8 (continued)

Predictor Variable	*OR*	*Unadjusted 95% CI*	*p*	*OR*	*Partially adjusted 95% CI*	*p*	*OR*	*Fully adjusted 95% CI*	*p*
IMD score	0.99	0.97 to 1.01	0.47	0.99	0.97 to 1.02	0.67			
Sport England Segmentation			0.48			0.48			
S19 (Elsie & Arnold)		Reference			Reference				
S17 (Ralph & Phyllis)	0.84	0.52 to 1.36		0.84	0.52 to 1.36				
S13 (Roger & Joy)	0.69	0.41 to 1.18		0.69	0.41 to 1.18				
S11 (Philip)	0.49	0.23 to 1.05		0.49	0.23 to 1.05				
S8 (Jackie)	0.91	0.19 to 4.25		0.91	0.19 to 4.25				
S6 (Tim)	0.72	0.43 to 1.22		0.72	0.43 to 1.22				
S3 (Chloe)	0.65	0.36 to 1.18		0.65	0.36 to 1.18				

Sample sizes for the unadjusted analyses ranged from 2336 to 2415; sample size for the adjusted analysis was 2174. Missing data for individuals (cases) was omitted from the analysis (listwise deletion).

5.3.4 Total leisure-time physical activity

5.3.4.1 Personal factors

The linear regression analyses revealed that being male, under 35, of normal body mass index and in good health, were all associated with increased leisure-time physical activity (LTPA) in the fully-adjusted model (LTPA; Table 5-9). In terms of occupational activity, people with sitting or standing occupations did less MET-minutes per week of physical activity than people who were not employed. People with physical jobs did the most LTPA per week, across all regression models. Owning a dog was also associated with increased LTPA in the fully adjusted model. Participants who didn't have a long-term illness or disability, had access to a car/s in the household, and who left education at a later age reported more MET-minutes a week of physical activity in unadjusted models only. Having children in the household was not associated with total leisure-time physical activity behaviour.

5.3.4.2 Social factors

Participants with moderate 'commitment to doing more physical activity' levels reported the least LTPA. Positive activity social norms and physical activity habits were associated with increased leisure-time physical activity, in all models. Village supportiveness for activity was also positively associated with leisure-time physical activity, but only in the unadjusted model.

5.3.4.3 Environmental factors

Inconvenience of public transport, and using facilities outside the local village were both associated with increased leisure-time physical activity

behaviour in the fully adjusted model. Having natural activity facilities and a community centre in the local area, ‘safety of walking after dark’, as well as using recreational facilities more recently were all positively associated with LTPA, but only in the unadjusted and partially adjusted models. The ‘proximity and convenience of walking’ was positively associated with LTPA in the unadjusted model only. There was no association between physical activity and the ‘traffic and pleasantness of surroundings’, ‘safety and convenience of cycling’ or the locality of manmade sports facilities.

5.3.4.4 Gender interactions

‘Convenience of public transport’ was the only variable that had a significant interaction with gender (p-value for interaction = 0.039). There was little evidence of an association between convenience of public transport and total leisure-time physical activity for females (p=0.14). Males, however, with ‘neutral’ (adjusted mean difference = -508, 95% CI: -1061 to 45) or ‘favourable’ (adjusted mean difference = -524, 95% CI: -959 to -90) opinions about the convenience of public transport did less leisure-time physical activity than those with ‘unfavourable’ opinions on the convenience of public transport (p=0.03).

5.3.5 Village-level factors

None of the village-level factors were significantly associated with reported leisure-time physical activity (Table 5-8; 5-9). These results suggest that Sport England Segmention was not associated with physical activity and, therefore, that this is not the most suitable method for classifying individuals or areas.

Table 5-9 Regression coefficients for MET-minutes/week physical activity (total LTPA)—linear regression

	Unadjusted			*Partially adjusted*			*Fully adjusted*		
Predictor Variable	*Coeff.*	*95% CI*	*p*	*Coeff.*	*95% CI*	*p*	*Coeff.*	*95% CI*	*p*
Personal factors									
Gender			<0.001			<0.001			<0.001
Male		Reference			Reference			Reference	
Female	-519	-763 to -274		-664	-915 to -412		-597	-841 to -352	
Age Groups (years)			<0.001			0.009			0.002
18-34		Reference			Reference			Reference	
35-49	-864	-1378 to -351		-484	-1002 to 34		-694	-1182 to -206	
50-64	-596	-1088 to -103		-315	-832 to 202		-368	-843 to 108	
65+	-1249	-1744 to -754		-784	-1362 to -207		-787	-1318 to -255	
BMI Category			<0.001			<0.001			0.02
Normal weight		Reference			Reference			Reference	
Overweight	-540	-804 to -277		-485	-744 to -226		-365	-618 to -111	
Obese	-879	-1232 to -525		-409	-766 to -52		-195	-540 to 151	
Health			<0.001			<0.001			<0.001
Poor/Fair		Reference			Reference			Reference	
Good	939	601 to 1278		786	402 to 1170		505	153 to 857	
Excellent/Very good	1765	1444 to 2086		1463	1053 to 1874		836	481 to 1190	
Long-term Illness/Disability			<0.001			0.46			
Yes		Reference			Reference				
No	947	687 to 1208		123	-207 to 453				
Education leaving age (years)			0.004			0.08			
16 & under		Reference			Reference				
17-18	449	146 to 752		345	41 to 649				
19+	379	103 to 654		158	-126 to 442				

Table 5-9 (continued)

Predictor Variable	Coeff.	*Unadjusted* 95% CI	p	Coeff.	*Partially adjusted* 95% CI	p	Coeff.	*Fully adjusted* 95% CI	p
Occupation Category			<0.001			<0.001			<0.001
Not employed		Reference			Reference			Reference	
Sitting/standing job	-84	-341 to 173		-549	-866 to -231		-526	-831 to -222	
Physical job	1274	921 to 1627		534	138 to 929		530	147 to 912	
Cars in Household			<0.001			0.47			
No car		Reference			Reference				
1 car	1143	516 to 1770		373	-300 to 1046				
2+ cars	1627	1009 to 2244		432	-260 to 1125				
Children Under15 in Household			0.98			0.19			
Yes		Reference			Reference				
No	-4	-292 to 285		247	-122 to 616				
Dog Ownership			<0.001			0.005			0.03
Yes		Reference			Reference			Reference	
No	-527	-770 to -284		-354	-602 to -107		-262	-501 to -23	
Social factors									
Commitment to doing more PA			0.002			0.04			0.03
Low		Reference			Reference			Reference	
Moderate	-114	-398 to 170		-332	-606 to -59		-317	-599 to -36	
High	403	111 to 696		-71	-357 to 215		18	-286 to 322	
Social Norms			<0.001			0.01			<0.001
Unfavourable		Reference			Reference			Reference	
Neutral	474	140 to 807		71	-252 to 395		154	-170 to 478	
Favourable	1096	813 to 1379		398	110 to 686		513	228 to 799	
Habit			<0.001			<0.001			<0.001
Unfavourable		Reference			Reference			Reference	
Neutral	814	361 to 1267		736	282 to 1191		447	-16 to 910	
Favourable	2245	1974 to 2516		2100	1809 to 2390		1557	1244 to 1870	

Table 5-9 (continued)

Predictor Variable	*Coeff.*	*Unadjusted 95% CI*	*p*	*Coeff.*	*Partially adjusted 95% CI*	*p*	*Coeff.*	*Fully adjusted 95% CI*	*p*
Village Supportiveness			<0.001			0.77			
Unfavourable		Reference			Reference				
Neutral	409	109 to 708		76	-215 to 367				
Favourable	553	273 to 833		-43	-324 to 238				
Environmental factors									
Traffic and pleasantness of surroundings			0.06			0.40			
Unfavourable		Reference			Reference				
Neutral	-139	-618 to 339		-189	-666 to 288				
Favourable	257	-110 to 624		67	-308 to 443				
Proximity and convenience of walking			0.02			0.08			
Unfavourable		Reference			Reference				
Neutral	397	37 to 757		343	-17 to 703				
Favourable	-83	-351 to 185		-47	-319 to 225				
Safety and convenience of cycling			0.14			0.17			
Unfavourable		Reference			Reference				
Neutral	109	-176 to 395		146	-139 to 431				
Favourable	304	-1 to 608		297	-10 to 605				
Convenience of public transport			0.06			0.01			0.04
Unfavourable		Reference			Reference			Reference	
Neutral	-25	-382 to 332		-137	-497 to 222		-52	-391 to 287	
Favourable	-336	-619 to -52		-450	-741 to -160		-348	-617 to -80	
Safety walking after dark			0.003			0.03			0.22
Unfavourable		Reference			Reference			Reference	
Neutral	-224	-601 to 152		-210	-589 to 168		-90	-451 to 271	
Favourable	304	24 to 585		224	-69 to 518		164	-108 to 436	

Table 5-9 (continued)

Predictor Variable	Unadjusted Coeff.	Unadjusted 95% CI	Unadjusted p	Partially adjusted Coeff.	Partially adjusted 95% CI	Partially adjusted p	Fully adjusted Coeff.	Fully adjusted 95% CI	Fully adjusted p
Manmade sports facilities in the local area			0.06			0.70			
1+ facility		Reference			Reference				
No facilities	-240	-493 to 14		-52	-316 to 212				
Natural activity facilities in the local area			0.02			0.58			
1+ facility		Reference			Reference				
No facilities	-864	-1592 to -135		-214	-981 to 553				
Community centre/village hall in the local area			0.003			0.02			0.11
Yes		Reference			Reference			Reference	
No	-450	-749 to -152		-373	-689 to -58		-239	-527 to 50	
Use of recreational facilities			<0.001			<0.001			0.05
No facilities used		Reference			Reference			Reference	
Used in last year only	69	-530 to 668		154	-568 to 877		-126	-833 to 580	
Used in last month	1083	605 to 1561		1111	459 to 1763		351	-294 to 997	
Locality of facilities used			0.001			<0.001			0.007
No facilities used		Reference			Reference			Reference	
Local village only	43	-344 to 429		-424	-893 to 44		263	-714 to 189	
Outside local village	775	330 to 1220		461	-59 to 981		297	-198 to 791	
Local and not local	318	-30 to 666		-304	-745 to 137		-286	-709 to 137	
Village-level factors									
Population Density	20	-242 to 281	0.88	-1	-285 to 282	0.99			
Mean age	14	-28 to 56	0.52	-2	-61 to 58	0.96			
Gender (% males)			0.24			0.20			
Low		Reference			Reference				
Moderate	294	-49 to 636		317	-28 to 662				
High	125	-218 to 469		161	-201 to 524				

Table 5-9 (continued)

Predictor Variable	*Coeff.*	*Unadjusted 95% CI*	*p*	*Coeff.*	*Partially adjusted 95% CI*	*p*	*Coeff.*	*Fully adjusted 95% CI*	*p*
IMD score	3.47	-32 to 39	0.85	1	-37 to 39	0.94			
Sport England Segmentation			0.38			0.38			
S19 (Elsie & Arnold)		Reference			Reference				
S17 (Ralph & Phyllis)	-46	-779 to 688		-46	-779 to 688				
S13 (Roger & Joy)	-127	-948 to 695		-127	-948 to 695				
S11 (Philip)	-567	-1810 to 676		-567	-1810 to 676				
S8 (Jackie)	1091	-1187 to 3369		1091	-1187 to 3369				
S6 (Tim)	-260	-1064 to 544		-260	-1064 to 544				
S3 (Chloe)	-652	-1592 to 288		-652	-1592 to 288				

Sample sizes for the unadjusted analyses ranged from 2336 to 2415; sample size for the adjusted analysis was 2179.

5.3.6 Ancillary analysis

An ancillary analysis was conducted for the ‘commitment to do more physical activity’ variable. It was hypothesised that the lack of association between ‘commitment to do more physical activity’ and reported physical activity was due to the majority of participants being sufficiently physically active, and, therefore, having low commitment levels to do more physical activity. To investigate this, the regression models were repeated with only those participants who did not report doing sufficient activity to meet the recommended guidelines (Table 5-10). Commitment to doing more physical activity was significantly positively associated with LTPA in the unadjusted and partially adjusted models, but not in the fully adjusted model.

5.3.7 Village- and individual-level variance

Only 2.4% of the variation in reported leisure-time physical activity was at the village level (i.e., 97.6% was at the participant level). The fully adjusted model explained 72.6% of the between-village variation and 18.7% of the participant-level variation in physical activity (R^2 statistic).

Table 5-10 Regression coefficients for MET-minutes/week physical activity (participants who didn't meet the recommended guidelines)—linear regression

		Unadjusted			*Partially adjusted*			*Fully adjusted*	
Predictor Variable	*Coeff*	*95% CI*	*p*	*Coeff*	*95% CI*	*p*	*Coeff*	*95% CI*	*p*
Commitment to doing more physical activity			<0.001			<0.001			0.19
Low		Reference			Reference			Reference	
Moderate	47	15 to 80		34	1 to 68		10	-26 to 46	
High	99	60 to 137		75	35 to 115		40	-4 to 85	

5.4 Discussion

The purpose of this study was to examine the personal, social and environmental correlates of physical activity in rural adults from the United Kingdom. A number of variables were identified as correlates of physical activity behaviour. Gender, health status, commitment to doing more physical activity, social norms, physical activity habit and reported use of recreational facilities were all associated with both meeting the recommended guidelines and total reported LTPA. Age, BMI, occupational activity, dog ownership, locality of recreational facilities, and convenience of public transport were only correlates for total LTPA.

While cross-sectional data are useful for identifying associations, analyses of longitudinal data provide a stronger basis for inferring causality (Bauman et al., 2012; Van Stralen et al., 2009). In one review, Bauman et al. (2012) identified health status as one of the clearest predictors of change for physical activity behaviour in adults. There was also consistent evidence to suggest personal history of physical activity during adulthood (similar to ‘physical activity habit’; Trost et al., 2002; Van Stralen et al., 2009), and intention to exercise (similar to ‘commitment to do more physical activity’ Rhodes et al., 1999; Trost et al., 2002; Van Stralen et al., 2009), were both predictors of change for physical activity behaviour. Reviews suggest that social norms are neither associated cross-sectionally with physical activity, nor predictors of change in physical activity behaviour (Bauman et al., 2012). Therefore, findings from the present study imply that rural populations are similar to the general population in terms of the association between health status, physical activity habit, commitment to be more active, and their reported physical activity behaviour. The association between social norms and physical activity in the present study suggests, however, that social norms may be a uniquely important factor for rural populations.

Other correlates of physical activity reported in the literature are male sex (Rhodes et al., 1999; Trost et al., 2002), age (negatively; Kaewthummanukul & Brown, 2006; Rhodes et al., 1999; Trost et al., 2002), and overweight (negatively; Trost et al., 2002). Our findings concur with this research, although age and overweight status were only associated with total leisure-time physical activity and not the likelihood of meeting the guidelines. In line with previous research, dog owners report more physical activity than people who do not own dogs (Cutt, Giles-Corti, Knuiman, & Burke, 2007; Cutt, Giles-Corti, Knuiman, Timperio, & Bull, 2008; Sehatzadeh, Noland, & Weiner, 2011).

Accessibility of recreation facilities has been found to be the most consistent environmental predictor of activity and change in physical activity behaviour in reviews (Bauman et al., 2012; Humpel, Owen, & Leslie, 2002; Van Stralen et al., 2009; Wendel-Vos, Droomers, Kremers, Brug, & van Lenthe, 2007). In the present study, how recently participants had used recreational facilities, and the locality of facilities used, were both associated with physical activity behaviour. Logically, the more recently participants had used a recreational facility, the more likely they were to have met the recommended guidelines. Research from urban populations has found that local recreational facilities are visited more frequently than those located further away (Hoehner, Brennan Ramirez, Elliot, Handy, & Brownson, 2005; McCormack, Giles-Corti, Bulsara, & Pikora, 2006). However, in our study the mixed outcome for locality of facilities used suggests that it is less important for rural populations where facilities are located. It may be suggested that rural adults have to travel to use facilities because there are limited facilities available within local villages. However, in fact, nearly all participants (97%) perceived there to be at least one natural activity facility in their local area, with 61% perceiving there to be at least

one man-made sports facility. It, therefore, seems that recreational facilities were available in these rural locations. Although some facilities may have been available locally, this does not necessarily mean residents used them regularly. It is plausible that if individuals had a desire to do a particular activity that was not offered locally, or had a personal preference for a certain facility, they might have been willing to travel the necessary distance. This finding warrants further investigation, in order to understand whether rural adults would benefit from more recreational facilities in their local village.

Convenience of public transport was negatively associated with leisure-time physical activity. This finding contradicts a recent review paper that found greater access to public transport to be positively associated with walking behaviour (Rissel, Curac, Greenaway, & Bauman, 2012). This may be due in part to the limited public transport services available in rural Devon, with 59% of participants reporting unfavourable responses for the convenience of public transport. Additionally, this study only measured convenience of public transport, rather than use. Thus, it may be that individuals who regularly used public transport also did more walking than individuals who did not.

5.4.1 Strengths and limitations

Two key strengths of this study are the large sample size (n=2,415), and the random selection of participants. Additionally, the study examined a range of personal, social and perceived environmental factors, in addition to village-level factors. Although this study forms part of a longitudinal study, the data presented here are cross-sectional and, therefore, can only be used to examine associations rather than to draw inferences regarding causality. Despite being better than

anticipated, and comparing well with other survey studies from the United Kingdom (15.9%, Ogilvie et al., 2008; 17%, Sahlqvist et al., 2011), the response rate was low (37.7%). This raises concerns that those who consented may not represent the wider population (non-response bias; Delgado-Rodriguez & Llorca, 2004). However, the participants in the present study were similar to the wider population in terms of IMD score and the population density of the village they resided in. Compared to the wider population, however, the survey respondents tended to be older, with a greater proportion being female. Previous research suggests females and older adults are often over-represented in health surveys (Craig et al., 2009). Two-thirds of the population reported meeting the recommended guidelines, suggesting that those of higher activity levels tend to be over-represented. While an unrepresentative sample is compromised when estimating a mean or prevalence, such data are generally robust for examining relationships between variables, in this case between physical activity and potential correlates. A further limitation of this study is the use of self-reported data. We used established and validated measures where possible, but although the IPAQ-SV has been found to have acceptable levels of test-retest reliability (r=0.76; Helmerhorst et al., 2012), recent reviews have questioned the levels of criterion validity ($\rho = 0.30$, 95% CI 0.23 to 0.36, Craig et al., 2003; median $\rho = 0.29$, range 0.09 to 0.39, Lee et al., 2011). Self-report measures of physical activity tend to include bias due to social desirability and participants may find it difficult to recall activities from the past seven days. The fact that self-reported height and weight were used to calculate body mass index is another limitation, because of social desirability bias to over-report height and under-report weight (Rowland, 1990). Despite this, Goodman and Strauss (2003) stated that self-report measures are acceptable in epidemiological studies given that self-report measures are correlated

with measured height and weight. Finally, participants were not asked about their ethnic origin in the questionnaire. This was, however, a deliberate decision, because only 2.5% of the rural population of Devon are from non-white British ethnic groups (Office for National Statistics, 2012).

5.4.2 Implications

Despite the noted limitations, our findings are important from a public health perspective, in terms of understanding the unique characteristics of rural populations, through focusing on the personal, social, and environmental correlates of physical activity. Regular physical activity plays a key role in reducing the risk factors for several chronic conditions. Therefore, the identification of physical activity correlates may help researchers, clinicians, and health policy makers to design population-specific interventions. This study adds to the limited research available on physical activity in rural communities from England. The results from the present study suggest that rural populations are similar to urban populations in terms of the correlates of physical activity behaviour. However, our findings do imply that social norms may be more influential for rural populations, compared to their urban counterparts. Contradictory to research from urban populations, there was a negative association between convenience of public transport and physical activity, and the most active individuals used recreational facilities exclusively outside of their local area. These findings suggest that rural and urban adults differ in terms of the way they interact with their environment, and that differences in the built environment have an influence on physical activity behaviour. To successfully change physical activity prevalence in rural populations, interventions should be tailored to modify the correlates of physical activity behaviour that are specific to rural adults, as identified

in the present study. Interventions can be tailored to rural needs by putting more of an emphasis on improving the social norms for physical activity. Social norms are defined as what individuals perceived other people in their neighbourhood or whom they knew to be doing in relation to physical activity. One recommendation would be to utilise community champions, where members of the local community are involved in an intervention through participating and actively promoting physical activity to their peers.

5.4.3 Future research

Future research should focus on longitudinal studies with rural populations to examine the determinants of physical activity behaviour, to aid the understanding of the causal role and direction of effect of correlates. It is also recommended that the physical activity correlates from this and other similar studies be used to help develop future physical activity interventions specifically tailored to rural communities, and that rigorous evaluation methods be undertaken to determine the effectiveness of such programmes.

5.5 Conclusions

This study aimed to examine the personal, social and environmental correlates of physical activity behaviour in rural adults from south-west England. Both individual and village-level predictors were included in the analysis, with gender, health, commitment to being more active, activity habits, social norms, and use of recreational facilities revealed as the clearest correlates of physical activity behaviour. Although most of the results were in line with previous research, this study did highlight some unique characteristics of the rural population.

Understanding the correlates that influence physical activity behaviour is important for the designing of effective physical activity interventions, but generally the relationship between these correlates is complex and typically understudied, especially in rural populations. This study has been published in the International Journal of Behavioral Nutrition and Physical Activity (Appendix K).

In the following chapter, I describe the methods used to collect and analyse data in the main study, which evaluated the effectiveness of the Devon Active Villages community-level physical activity intervention. I also present the findings from the evaluation study, and discuss these in relation to findings from other evaluation studies, and the study's own strengths and limitations.

CHAPTER 6.

Devon Active Villages evaluation study

In the previous chapter I described the methods used to collect and analyse data in the cross-sectional study of physical activity correlates. I presented the results from the regression analyses, and discussed the findings in relation to other studies of physical activity correlates and predictors of change from both rural and urban populations. The strengths and limitations of the cross-sectional study were also discussed. In this chapter, I describe the aims of the main evaluation study, and the stepped wedge randomised controlled trial methodology. The main findings from the data analysis are presented and discussed in relation to findings from other community-level physical activity interventions. I also examine the concordance between reported participation in intervention events and the actual registration details from Active Devon, and explore the impact of the evaluation study.

6.1 Aims of the study

The aim of the main study was to evaluate the effectiveness of a community-level physical activity intervention—'Devon Active Villages'—using a stepped wedge cluster randomised controlled trial design. The primary outcome of interest was whether the intervention had any effect on the proportion of participants who reported sufficient physical activity to meet the government recommended physical activity guidelines. The total moderate-and-vigorous-intensity physical activity that participants reported was analysed as a key secondary outcome. Other secondary outcomes included physical activity habits, social norms, village supportiveness of

physical activity, commitment to doing more physical activity, as well as locality and use of recreational facilities.

The study aimed to examine the community-level impact of the intervention, rather than the intervention's effect on individual participants. This is due to Active Devon's objective for the intervention to have an effect on physical activity levels in the community as a whole, not just on the individuals that participated in Devon Active Village events.

6.2 Methods

The study protocol was based on a stepped wedge cluster randomised controlled trial design. Ethical approval for the study was obtained from University of Exeter Sport and Health Sciences Ethics Committee (Appendix H).

6.2.1 Participants

The study took place in the seven rural regions of Devon, south-west England. Villages with populations of 500–2000 people formed the sampling frame for the intervention. The range of eligible population sizes were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities they could offer. In the initial planning of the intervention, Active Devon identified 155 rural villages to receive the Devon Active Villages intervention across the course of three years.

Prior to the intervention, Active Devon ran a pilot intervention with 15 villages, the outcome of which was used to inform the main intervention protocol. Of the remaining 140 villages that were not part of the pilot, twelve could not be included in the evaluation due to engagement with local community members before baseline

data collection had commenced. Thus, the remaining 128 villages (clusters) were recruited. The time period (stage) in which villages first received the intervention was randomised (stratified by region) using computer generated random numbers. The first period took the form of a baseline period, where no villages received the intervention. The intervention was administered sequentially to 128 villages over the subsequent four time periods (Figure 6-1). The number of villages that were to receive the intervention at each period in each village was pre-specified by Active Devon, placing further restriction on the allocation sequence. Twenty-two villages received the intervention in the second period (April-June 2011), 36 in the third period (September-November 2011), 35 in the fourth period (April-June 2012), and 35 in the fifth period (September-November 2012).

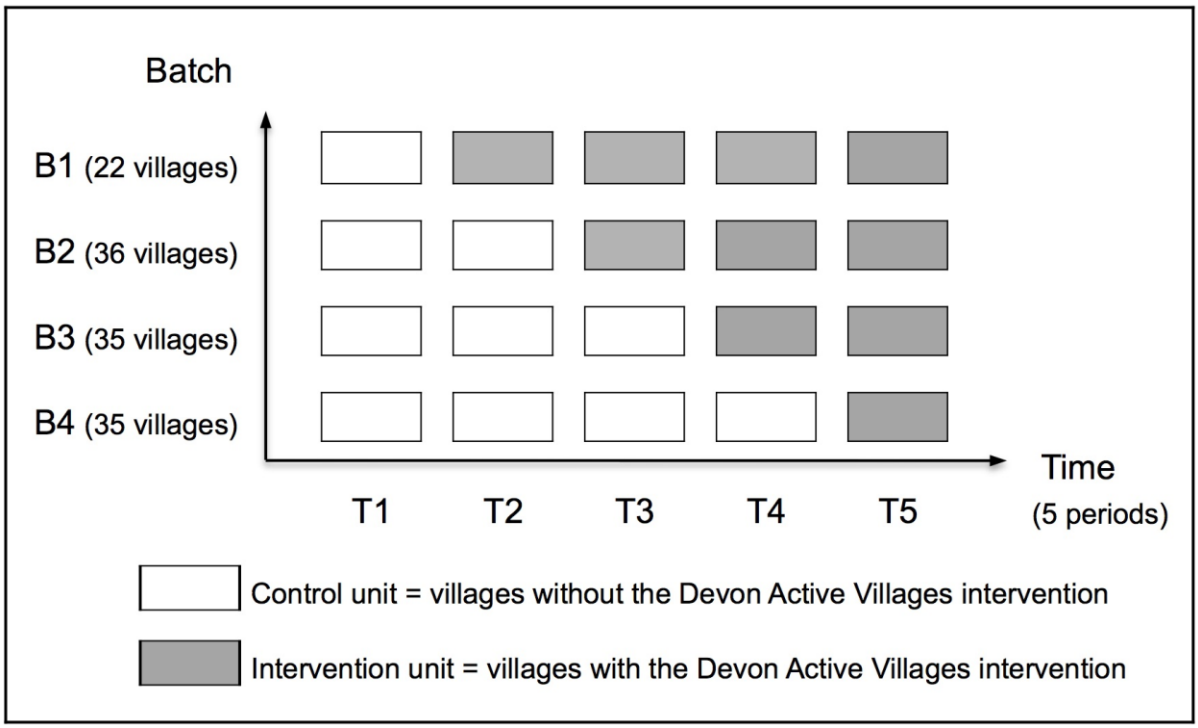


Figure 6-1 Stepped wedge study design. One batch (B1, B2, B3, B4, B5) represents one group of intervention villages. Each time period (T1, T2, T3, T4, T5) represents a data collection point. Each unit (control or intervention) represents one time period of one batch.

Data collection for the evaluation took the form of a postal survey conducted at five fixed time points: baseline (in the month prior to commencement of the first intervention period) and within a month of the end of each of the four intervention periods (Figure 6-2). Questionnaires were sent out in March 2011 (Stage 1), July 2011 (Stage 2), January 2012 (Stage 3), July 2012 (Stage 4) and January 2013 (Stage 5). A repeated cross-sectional design was employed, in which a random sample of households within each village was selected to receive the survey at each stage. The addresses of all households in each of the 128 study villages were purchased from a private company (Address List Utility, Arc en Ciel, Version 3.1 PAF Quarter 1, 2011), and the order in which households were approached to participate in the survey at each stage was randomly generated. The randomisation procedure was conducted by a third party researcher, and stratified by the village each household belongs to. If the number of completed questionnaires returned within three weeks of the initial mailing was insufficient, additional questionnaires were sent out to new households.

Households were sent a questionnaire, a participant information sheet, and a prepaid return envelope. One adult per household was randomly selected. If there were multiple eligible adults in the household, an invitation to complete the survey was given to the adult who had most recently had a birthday. As long as participants were 18 years or over (no upper limit), and lived in the household that received the survey there was no other exclusion criteria. The survey consisted of 28 questions and, based on estimates obtained during pilot work, took participants approximately 10-15 minutes to complete. Informed consent was implied when participants returned a completed questionnaire.

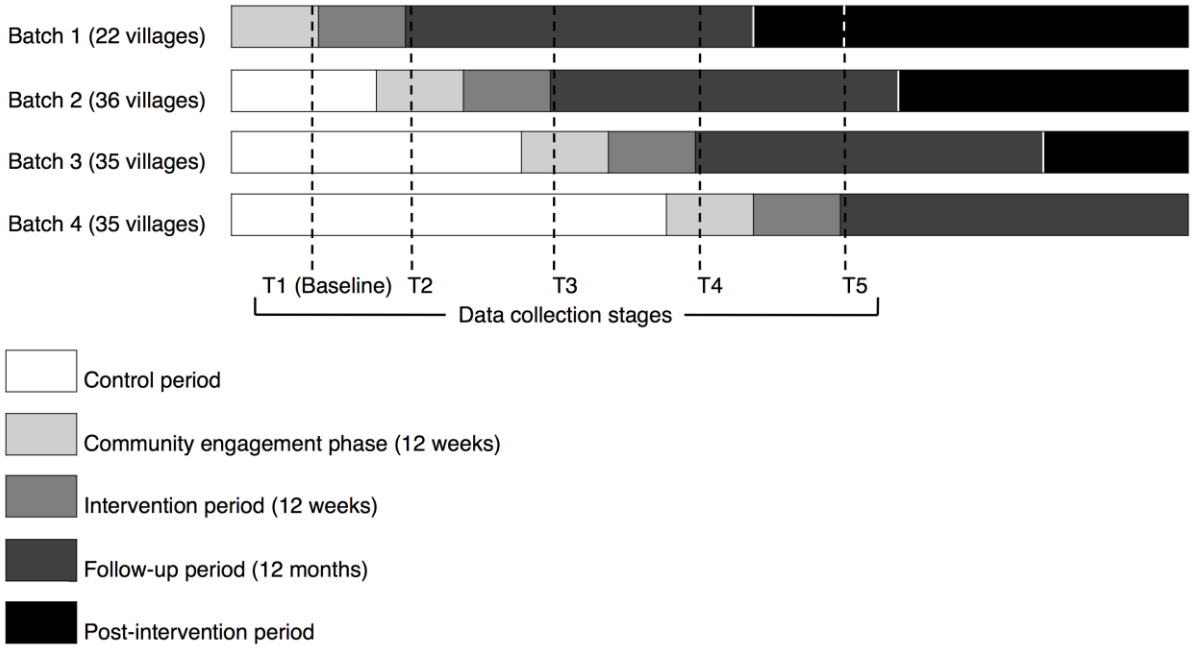


Figure 6-2 Data collection timeline.

6.2.2 Outcomes

The primary outcome was the proportion of participants who reported sufficient physical activity to meet the recommended physical activity guidelines, compared between the intervention and control modes as a binary outcome. A key secondary outcome was the total number of metabolic equivalent (MET) minutes per week, from which the primary outcome was derived. In addition to the above, the following outcomes were also examined: physical activity social norms, physical activity habits, perceived village supportiveness for physical activity, commitment to doing more physical activity, physical activity intentions, availability of recreational facilities in the local area, reported use of recreational facilities, and the locality of facilities used.

6.2.3 Measures

The survey measures have been described in detail previously (Chapter 5.2.2).

6.2.3.1 Psychosocial factors

Each item assessing physical activity social norms was dichotomised ("strongly disagree/disagree/neither" versus "strongly agree/agree"). The means for the 'physical activity habits' and 'perceived village supportiveness for physical activity' were taken, and the percentage of participants who scored equivalent to 1 or above (i.e., equivalent to "agree" or above) was calculated. The percentage of participants intending to do more activity within the next month or six months (as opposed to "not within the next six months" or "unlikely to ever") was compared between the intervention and control modes. Participants' 'commitment to doing more physical activity' was calculated as the mean of three constituent items, and then analysed as a continuous measure.

6.2.3.2 Perceived local environmental characteristics

Of the items assessing participants' awareness of recreational facilities, only the four facilities that we would have expected to be impacted on by the intervention ('walking routes/footpaths', 'local park/public green space', 'indoor sports facilities', and 'community centre/village hall') were analysed as binary outcomes. Participants were grouped according to whether they had used at least one of the eight recreational facilities within the "last month", in contrast to the "last 12 months" or "not at all". Participants were also grouped according to whether they had used

facilities in the “local village only” or “both inside and outside the village”, as opposed to “outside village only” or “not at all”.

6.2.3.3 Physical activity campaigns/programmes

In addition to the measures mentioned previously, participants were asked whether they were aware of the Devon Active Villages intervention, and if so, whether they had participated in any of its events. Participants who were aware of the intervention were also asked to select from the following response items those that most accurately reflected their opinions of the intervention: ‘I found it interesting’, ‘It’s a good campaign’, ‘It was directly relevant to me’, ‘It made me think about physical activity or exercise’, ‘It seemed irrelevant to me’, ‘It’s a waste of time’, ‘It’s a waste of money’, and ‘It had no effect on me at all’. The survey also contained questions on participants’ awareness of, and participation in, any local physical activity campaigns.

6.2.3.4 Village-level factors

Village-level factors were obtained from the 2011 Census (Office for National Statistics), including percentage of villagers who were male, age classification for adult villagers, and population density. The Index of Multiple Deprivation (IMD) score was obtained at the Lower Layer Super Output Area level (English Indices of Deprivation). Data on the penetration of the Devon Active Villages intervention were obtained from Active Devon. Everyone who participated in the intervention was required to complete a registration form before commencing activity. From the registration details, the proportion of the population from each of the study villages

attending an event was calculated, both for the whole village population and the adult population (aged 17 years or over).

6.2.4 Sample size

To detect an increase from 25% to 30% of people meeting the guidelines for recommended physical activity levels, with 80% power at the 5% significance level, ten participants were recruited from each of the 128 villages at each study period. The sample size was calculated using formulae presented by Hussey and Hughes (2007), and takes account of both within-village clustering and the number of villages receiving the intervention at each period. The intra-cluster (intra-village) correlation coefficient (ICC) for the primary outcome was assumed to be 0.02 based on published ICCs for three physical activity-related outcomes at the postcode sector level, estimated using data from the 1994 Health Survey for England (Gulliford, Ukoumunne & Chinn, 1999).

A recent pilot for a population study of travel behaviour in the United Kingdom achieved a response rate of approximately 20% for a short questionnaire postal survey (Sahlqvist et al., 2011). On this basis, 6,400 surveys were sent out at every period (50 surveys to each village), with the expectation that at least 1,280 would be completed and returned. When this response rate was not achieved within three weeks of surveys being posted, an additional five surveys were sent out to extra households for every one survey missing. It was possible that some individuals would receive the questionnaire more than once. In such cases, if returned, demographic variables (e.g., gender, age, height, weight) were used to identify this. These participants remained in the analysis, but it was recorded that each participant had completed the questionnaire on more than one occasion.

6.2.5 Statistical analysis

For all outcomes, the data collected across the five periods were used in a single analysis. Analyses applied the intention-to-treat principle, with participants analysed according to the trial mode their village (cluster) was in for the period at which they provided outcome data. Unadjusted and confounder-adjusted comparisons of the outcomes between intervention and control modes were implemented using random effects ("multilevel") linear regression, estimated using maximum likelihood (Schall, 1991) for continuous outcomes, specifying the village effect as random; and marginal logistic regression models using Generalised Estimating Equations (GEEs) with information sandwich ("robust") estimates of standard error for binary outcomes, specifying the correlation structure as exchangeable (Hanley, Negassa, Edwardes, & Forrester, 2003). The random effects model and GEEs methods allowed for the correlation between the outcomes of participants in the same village cluster, as is required for cluster randomised trials. For binary outcomes, when the intra-cluster (intra-village) correlation coefficient (ICC) was negative, instead of presenting the GEEs estimates, odds ratios from *ordinary* logistic regression were used. This issue does not arise for continuous outcomes as the random effects linear regression model does not allow negative values of the ICC.

For the comparisons between trial modes the data was in long form so that all scores for a given outcome across all 128 clusters and all 5 time intervals were stored in the same variable. The crude model for each outcome used the following predictors: intervention versus control mode status; and time interval (using dummy variables). The coefficient for the intervention mode status variable was the

estimated intervention effect. All analyses included period as a predictor. Adjusted models also included the following prognostic factors: region, gender, and age at the period of data collection.

For quantitative outcomes means and standard deviations were presented for each trial mode (i.e., intervention versus control) along with the mean difference between modes, confidence interval for the mean difference and p-value. For dichotomous outcomes the percentage with the outcome of interest (e.g., proportion meeting physical activity guidelines) were presented for each trial mode along with the odds ratio between modes, confidence interval for the odds ratio and p-value. The ICC of the outcome was reported based on the confounder-adjusted analyses. In addition, an exploratory test of interaction was used to assess whether the effect of the intervention differed across the seven regions, a proxy for local delivery partner. All analyses were carried out using Stata 12.1 software (StataCorp, 2011).

6.2.5.1 Sensitivity analyses

It is possible that the full effect of the intervention would not be realised immediately. To test this analyses were run comparing the intervention and control modes where data related to the first period in which the intervention is delivered for a village were removed from the analysis. Equally it was (more) possible that the intervention only has an immediate effect on the outcomes. To test this, analyses were run comparing the intervention and control modes where only data related to the first period in which the intervention was delivered, was compared to control mode data.

6.3 Results

6.3.1 Descriptive characteristics

Of the 32,315 surveys that were sent out, 10,412 were completed and returned (response rate 32.2%, range 30.3% at wave four to 37.7% at wave one). Of these, 38.8% were male, and the mean (SD) age was 58 (15) years. Compared to the general population of the intervention villages, the study participants tended to be older (71.9% versus 59.2% aged 50 years or over), and a greater proportion were female (61.2% versus 51%). The study participants were equivalent to the general village population in terms of their Index of Multiple Deprivation scores (mean (SD) 15.8 (4.0) for both study sample and general village population). The study participants were also extremely similar to the general population in terms of the population density of the village they resided within (mean (SD) 0.63 (0.5) for the study population versus 0.64 (0.6) for the village population). 4,693 participants provided data in the intervention trial mode and 5,719 in the control mode. The sample characteristics were similar between the intervention and control mode participants, with comparable responses being reported for gender, age, education leaving age, and car ownership (Table 6-3). A greater proportion of the intervention participants were in the least deprived quintile (25.7% compared to 21.3% of the control participants). More controls (22.2%) than intervention participants (15.8%) were in the most deprived quintile.

Table 6-3 Sample characteristics by trial mode

Variable	Trial mode	
	Intervention	*Control*
	(N = 4693)	*(N = 5719)*
Male, %	39.8	38.0
Age in years, mean (SD)	58.7 (15.3)	58.1 (15.3)
Education		
16 and under, %	36.5	38.1
17/18, %	25.8	26.3
19 and over, %	37.7	35.6
Car ownership		
No car	3.9	4.4
One car	37.8	39.2
Two or more cars	58.3	56.4
Indices of Multiple Deprivation (quintiles, %)		
1 (lowest)	25.7	21.3
2	20.9	16.8
3	19.8	19.2
4	17.8	20.4
5 (highest)	15.8	22.2

6.3.2 Intervention effects

There was little evidence of an intervention effect on meeting the recommended physical activity guidelines (adjusted OR: 1.02; 95% CI: 0.88 to 1.17; p=0.80; Table 6-4; Table 6-5), and uncertainty over the true size of the difference between intervention and control participants regarding metabolic equivalent minutes per week (adjusted mean difference: 171; 95% CI: -16 to 358; p=0.07). At one extreme, the intervention may have had no effect on MET minutes per week, while at

the other extreme it is plausible that the intervention improved physical activity levels by up to 358 metabolic equivalent minutes per week (equivalent to 90 minutes of moderate-intensity physical activity). Physical activity habits did differ between trial modes, with a greater percentage of the intervention participants having favourable activity habits than the control mode (51.5% versus 47.5%; adjusted OR: 1.18; 95% CI: 1.04 to 1.34; p=0.009). There were no between group differences in physical activity social norms, perceived village supportiveness for physical activity, intentions or commitment to doing more physical activity, awareness of local walking routes/footpaths, local parks/public green space, indoor sports facilities or a local community centre/village hall, or use and locality of recreational facilities.

Table 6-4 Crude comparison of physical activity variables by period

Period		Trial mode	
		Intervention	**Control**
1	N	-	2,409
	Meets physical activity guidelines, %	-	66.9
	Number of MET-mins/week, mean (SD)	-	2561 (2977)
2	N	312	1,625
	Meets physical activity guidelines, %	67.3	61.5
	Number of MET-mins/week, mean (SD)	2848 (3191)	2449 (3109)
3	N	921	1,082
	Meets physical activity guidelines, %	60.0	58.8
	Number of MET-mins/week, mean (SD)	2304 (3033)	2137 (2956)
4	N	1,380	522
	Meets physical activity guidelines, %	64.6	68.2
	Number of MET-mins/week, mean (SD)	2512 (3084)	2585 (2961)
5	N	1,971	-
	Meets physical activity guidelines, %	60.1	-
	Number of MET-mins/week, mean (SD)	2101 (2785)	-
Total	N	4,584	5,638
	Meets physical activity guidelines, %	61.9	63.9
	Number of MET-mins/week, mean (SD)	2317 (2964)	2450 (3014)

N – sample size

Table 6-5 Comparison of outcomes between trial modes

Outcome	Trial mode		Crude comparison	Adjusted comparison		
	Intervention	Control	statistic	Statistic (95% CI)	p-value	ICC
Met physical activity guidelines, %	61.9	63.9	1.03	1.02 (0.88 to 1.17)	0.80	0.008
Number of metabolic equivalent minutes/week, mean (SD)	2317 (2964)	2450 (3014)	155	171 (-16 to 358)	0.07	0.010
Family is interested in physical activity (social norms), %	62.1	59.7	1.13	1.12 (0.98 to 1.26)	0.09	0.008
People around me all seem to be exercising (social norms), %	18.5	18.4	1.03	1.03 (0.87 to 1.23)	0.72	0.039
Physical activity habits, %	51.5	47.5	1.19	1.18 (1.04 to 1.34)	0.009	0.004
Perceived village supportiveness for physical activity, %	8.2	7.7	0.99	0.99 (0.78 to 1.26)	0.94	0.001
Intend to do physical activity within the next 6 months, %	61.3	57.5	0.93	0.93 (0.82 to 1.06)	0.26	0.005
Commitment to physical activity, mean (SD)	5.7 (2.6)	5.5 (2.7)	0.1	0.1 (-0.1 to 0.2)	0.33	0.006
Aware of walking routes/footpaths in the local area, %	94.0	95.0	0.95	0.89 (0.64 to 1.26)	0.52	0.029
Aware of local parks/public green space in the local area, %	80.6	78.8	1.01	1.00 (0.83 to 1.19)	0.96	0.107
Aware of indoor sports facilities in the local area, %	34.4	32.9	1.00	0.97 (0.86 to 1.10)	0.62	0.260
Aware of community centre/village hall in the local area, %	83.9	80.9	1.02	0.97 (0.80 to 1.19)	0.80	0.095
Used recreational facilities within the last month, %	84.9	85.2	0.97	0.94 (0.78 to 1.13)	0.49	0.024
Used at least one recreational facility in the village, %	71.3	72.5	0.96	0.94 (0.82 to 1.09)	0.42	0.084

The trial mode statistics are the mean scores (or overall percentage) within the mode across all five periods (stages). Note that because all comparisons are adjusted for period the direction of effect does not necessarily correspond with the within mode summary statistics. A detailed breakdown of results within each period is shown in Table 6-4 for '*Meets physical activity guidelines'* and '*Number of MET minutes per week'*.

The comparative statistic is the Mean Difference for quantitative outcomes and the Odds Ratio for dichotomous outcomes. Sample size ranged from 3892 to 4693 in the intervention mode, and 4657 to 5719 in the control mode. Crude analyses adjusted for period. Adjusted analyses adjusted for period, gender, age and area.

There was little evidence that the effect of the intervention on meeting the recommended physical activity guidelines was modified by study area (interaction test p=0.62). Post-hoc analyses also showed there was little evidence that the intervention had a delayed effect (p=0.79), or an immediate effect that subsided (p=0.98).

Of the study participants in the intervention mode 16% reported awareness of Devon Active Villages, and 4% reported participation in intervention events (Table 6-6). Of those reporting awareness of the intervention, 50.6% agreed it was a good campaign, 29.8% found the intervention interesting, and 25.1% reported that the intervention made them think about physical activity or exercise. In total, 80% of the opinions on the Devon Active Villages intervention were positive.

Table 6-6 Participation and opinions on the DAV intervention†

Participation/opinion	**%**
Participated in the DAV intervention	25.0
Opinions on the DAV intervention:	
I found it interesting	29.8
It's a good campaign	50.6
It was directly relevant to me	16.2
It made me think about activity or exercise	25.1
It seemed irrelevant to me	7.4
It's a waste of time	1.2
It's a waste of money	2.6
It had no effect on me at all	13.0

† Sample size is the 745 (16.0%) participants from the intervention mode who were aware of the DAV intervention.

6.3.3 Intervention registrations

In the intervention villages, 5.2% of the population registered to participate in Devon Active Villages events (Table 6-7), although when children (aged 16 years and under) were excluded, this figure was reduced to 2.7%. Greatest participation in Devon Active Villages activities occurred in the villages that received the intervention in the second time period for the adult population (4.3%). Several villages failed to participate in the intervention, while others achieved up to 48% population penetration.

Table 6-7 Proportion of the population of study villages that registered as participants in the Devon Active Villages intervention

Batch*	**% total pop. Median (range)**	**% 17+ years pop. Median (range)**
1 (Period 2)	8.3 (0 to 24.8)	3.9 (0 to 20)
2 (Period 3)	6.9 (0 to 48)	4.3 (0 to 17.7)
3 (Period 4)	4.8 (0 to 19.2)	1.4 (0 to 13.2)
4 (Period 5)	3.9 (0 to 23.6)	1.0 (0 to 8.3)
Overall	5.2 (0 to 48)	2.7 (0 to 20)

* Each batch of villages represents all the villages that first received the intervention in the same specified period. The village is the unit of analysis.

6.4 Discussion

The aim of this study was to evaluate the effectiveness of Devon Active Villages, a community-level physical activity intervention delivered to rural villages. The Devon Active Villages intervention had no effect on the proportion of people active at recommended levels, and there was uncertainty regarding the true size of the increase in the number of MET-minutes per week reported,

as reflected in the 95% confidence interval for the mean difference. It is possible that the intervention was simply ineffective at changing behaviour, or if it was effective at the individual level, the low levels of population penetration prevented any observable effect at the village level.

Ensuring sufficient penetration and reach across a community to attain a population-level impact is one of the most difficult aspects of community-level interventions (Merzel & D'Affilitti, 2003). Although few studies reported population participation rates, one review found that the highest exposures were obtained for public information and screening activities rather than more intensive interventions, and that population penetration rates ranged from 4-60% (Merzel & D'Affilitti, 2003).

Baker et al. (2011) conducted a systematic review of community-level physical activity interventions and found that only three out of the 25 included studies reported positive changes in physical activity behaviour (Brown, Mummery, Eakin, & Schofield, 2006; Jiang, Wang, & Wu, 2008; Lupton, Fonnebo, & Sogaard, 2003). Jiang et al. (2008) conducted an intervention in urban communities within Beijing, finding a reported increase in regular physical activity in the intervention group (adjusted relative risk 1.20, 95% CI 1.09 to 1.31). However, the intervention achieved substantial penetration within the community (73% participation), through 'door-to-door' hand-outs and individualised counselling by health practitioners. In the Finnmark Intervention study (Lupton et al., 2003), a sport and activity-based intervention in a small artic community in Norway, males reported a significant increase (p=0.047) in physical activity behaviour six years after the initial baseline measurement. No change was found in the female population, however. Similar to the Beijing study, the Finnmark Intervention reached large segments of the population,

through community engagement, mass media, and individual counselling. The only other study in the review to find an increase in physical activity was the Rockhampton 10,000 Steps Project (Brown et al., 2006), where the proportion of females who met the recommended guidelines increased significantly from baseline to post-intervention. The study found no evidence of physical activity behaviour change in males. Again this intervention involved a large number of components, including social marketing, pedometers, individual counselling, partnering with local organisations, and environmental changes.

In contrast, the studies that reached a smaller proportion of the population, either through low cost or low activity, found no intervention effect on physical activity (Baker et al., 2011). For example, the low cost of one intervention in rural municipalities in Denmark limited the amount of intervention activities that took place, resulting in the intervention being purely mass-media (Osler & Jespersen, 1993). Simon et al. (2008) was one example of a low reach intervention, aimed at school communities in France. Although the intervention initially aimed to reach the whole community, in actuality, the vast majority of the intervention activities were targeted at one specific section of it. This was similar to Devon Active Villages, where many of the intervention activities were targeted at a specific group within the community (i.e., basketball for primary school children, or armchair aerobics for older adults). From the population penetration rates achieved by Devon Active Villages, it is clear that the intervention would be classed as ‘low reach’. Therefore, the results of the present investigation are in line with previous research, where interventions with low reach failed to have an effect on physical activity behaviour (Baker et al., 2011).

Despite the above, the intervention was associated with stronger activity habits, suggesting that those in the intervention mode perceived themselves to be physically active, but did not report a greater level of physical activity than controls. Physical activity habits was the only outcome for which there was evidence of an effect. We are not aware of any other community interventions that have reported physical activity habit as an outcome.

The majority of reported intervention opinions were positive, suggesting that the intervention was well-received by the small proportion of participants who were aware of its existence.

6.4.1 Strengths and limitations

Strengths of the study include the large sample size (>10,000) and the large number of participating villages. Incorporating multiple data collection stages into the research meant that it was possible to analyse both whether the intervention had an immediate effect on physical activity that later subsided, or whether the intervention effect was delayed. Each village acted as its own control, meaning communities were not subjected to “best-fit” matching with control communities. Another strength is that the period in which villages first received the intervention was randomly allocated, eliminating any selection bias. Indeed, in a recent review of community-level physical activity interventions (Baker et al., 2011), only one study out of 25 used randomisation to allocate communities (Simon et al., 2008).

This study fills a gap in the literature by being the first to use a stepped wedge cluster randomised trial design to evaluate a physical activity intervention. The stepped wedge trial design was the most appropriate study design for this intervention for three reasons: first, there was a necessity to

deliver the intervention in waves due to limited resources; second, once the intervention was implemented it was never fully taken away; and third, the intervention was delivered to all eligible communities of a certain size within the county (Hussey & Hughes, 2007). Despite the stepped wedge trial design requiring greater data collection and longer trial duration (Hussey & Hughes, 2007), it was successfully able to capture the effect of a pragmatic community-level physical activity intervention.

Despite being better than anticipated, and comparing well with other survey studies from the United Kingdom (15.9% (Ogilvie et al., 2008), 17% (Sahlqvist et al., 2011)), the response rate was low (32.2%). Non-response bias often occurs in survey studies, where non-responders may differ in some way from those who do respond (Delgado-Rodriguez & Llorca, 2004). The participants in the present research were similar to the wider population in terms of Indices of Multiple Deprivation score and the population density of the village they resided in. Compared to the wider population, however, the survey respondents tended to be older, with a greater proportion being female. Previous research suggests females and older adults are often over-represented in health surveys (Craig et al., 2009). Survey respondents also tend to report being healthier and doing more physical activity than the general population (Macera, Jackson, Davis, Kronenfeld, & Blair, 1990). Two-thirds of the present research population reported meeting the recommended guidelines, suggesting that those of higher activity levels were over-represented. However, previous research suggests that the IPAQ-SV has a tendency to over-report time spent doing physical activity (Ekelund et al., 2006; Lee et al., 2011; Rzewnicki, Auweele, & De Bourdeaudhuij, 2003;), with one review finding that

the IPAQ-SV over-reported physical activity on average by 106% (Range 36-173%; Lee et al., 2011).

Individuals may have over-reported exposure to the Devon Active Villages intervention events because they believed this response to be favourable to the researchers (Grant et al., 2005). However, the high level of consistency between the reported participation and participation according to village registrations suggests that such reporting bias was not present in this study. In addition, while the generally positive intervention opinions may have been an accurate representation of how well the intervention was received, participants may have reported overly positive opinions in an attempt to stop any intervention funding from being withdrawn (Delgado-Rodriguez & Llorca, 2004).

The main limitation of this research is the use of self-reported data. Self-reported outcome measures of physical activity tend to include bias due to social desirability and may lead to some misclassification, with some participants finding it difficult to recall activities from the past seven days. Nevertheless, there is no reason to believe that any misclassification was systematically different with regard to intervention or control group. Furthermore, established and validated measures were used where possible (e.g., the IPAQ-SV to measure physical activity).

Repeated cross-sectional samples of participants were used in this research in order to measure the community-level impact of the intervention on physical activity levels, rather than follow individuals over time to detect individual changes in behaviour. Although it is possible that the repeated cross-sectional samples included people new to the village who were not exposed to the intervention, it is perhaps more likely that there was contamination due to

people in control villages participating in neighbouring village intervention activities. Both of these factors would have attenuated intervention effects (Merzel & D'Affilitti, 2003). Finally, it may be that the reach, intensity and duration of the intervention were insufficient to achieve a population-level impact.

The Devon Active Villages evaluation study has been written up and has been submitted for publication in the International Journal of Behavioral Nutrition and Physical Activity (Appendix L).

6.5 Intervention concordance

It was important to gain an understanding of how well self-reported participation in intervention events correlated with actual participation rates. In order to achieve this, study respondents who reported participating in Devon Active Villages events were matched with the intervention registration information from Active Devon, based on their address and demographic details.

All participants in Devon Active Villages events were required to complete a registration form prior to partaking in any activities. The registration form asked participants for personal information (name, address, email address, age, gender, nationality, ethnicity, disability, education, and physical activity behaviour). A coding system was developed for use in the postal survey study, in order to identify the completed responses. The coding system was able to identify at which stage the survey was completed, as well as the region, village, and individual household that the respondent resided within. From the coding system the full address details, for all the study respondents who reported participating in intervention events, were obtained.

The Devon Active Villages registration database was searched for the

address details of the study respondents who reported participating in intervention events. If a match was found for address details, then demographic information (e.g., gender, age) was examined to ensure that it was the same individual under investigation, and not another individual in the household that also participated in intervention events. Overall 62.7% of the study respondents that reported participating in Devon Active Villages events also registered with Active Devon as an intervention participant. This meant that 37.3% of respondents who reported participating in intervention events did not register as a participant with Active Devon.

According to Active Devon there is information missing from the registration database, where registration details could not be collected from some individuals who participated, or the details collected were incomplete. An examination of the registration database revealed that 16.8% of the 10,974 registrants did not have full address details, either through providing an incomplete postcode, no postcode at all, a school address (e.g., for children partaking in after-school activities), or providing no home address information whatsoever. In total, full address information was not available for 1,843 individuals. Although this likely accounts for some of the discrepancies between self-reported and actual participation rates, it would be unrealistic to assume that this factor accounts for all of the discrepancy.

There are other possible reasons for the difference between self-reported and actual participation. Firstly, there may have been an element of reporting bias, where study participants give answers to questions in the direction they perceive to be of interest to researchers (Delgado-Rodriguez & Llorca, 2004). In the present study, respondents may have felt obliged to say they participated in Devon Active Villages events, because they believed that to be the ‘right’

answer to the question. Alternatively, respondents may have been worried that intervention funding could be withdrawn if they did not report participating in intervention events, removing the option for them to participate in the future if they wished to do so.

Second, there is a possibility that respondents confused the Devon Active Villages intervention with another campaign or programme. For instance, there was an arts/theatre campaign with a similar name (Villages in Action), which toured around Devon villages in the months prior to the start of the Devon Active Villages intervention. It is possible that study respondents had participated in the 'Villages in Action' campaign, rather than the Devon Active Villages intervention, and so mistakenly ticked the box on the survey to say they had participated (recall bias). However, during the data cleaning process, the responses to the question "What do you think the Devon Active Villages programme is about?" were screened. Any responses that appeared to be referring to another intervention (i.e., mentions of theatre/arts for the Villages in Action programme) were flagged as suspicious, and removed from the final analyses. Therefore, these responses did not count towards the proportion of participants that were aware of or participating in Devon Active Villages events.

Finally, many of the participants in Devon Active Villages events were children aged 5-16 years (57.5% of all registrants). Therefore, it is possible that some study respondents may have reported participating in intervention events on behalf of their children, in order to indicate that a member of their family had participated. Further examination of the registration database revealed a number of matches where the home address corresponded to the survey respondent who reported participating in intervention events, but the demographic details did not (i.e., child aged 5-16 years). These results indicate

that some individuals may have ticked the box to say they participated in Devon Active Villages events, but in actuality it may have been a member of the household that participated instead. Unfortunately, this suggestion is impossible to confirm.

6.6 Impact of the research

The impact of research can be both diverse and complex, where impact is defined as “an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia” (The Research Excellence Framework, 2012). Evaluating and quantifying the impact of research is not an easy task. However, understanding the impact of research is vitally important, so that funding can be prioritised to the research areas that produce the broadest impact (Arthur & Piatt, 2012).

The findings from the present research study indicate that unless community-level physical activity interventions can reach a substantial proportion of the target population, they are unlikely to be able to change the population prevalence of physical activity. This is an important finding for researchers, clinicians, health policy makers, and community health organisations alike, demonstrating that future interventions need to invest as much resource in the promotion of an intervention as the delivery of it (Table 6-8).

Table 6-8. Impact of the research study for practice, research, and policy

	Practice	Research	Policy
Audience	• Active Devon • Sport England • Other sport and physical activity partnerships (similar to Active Devon)	• Researchers with interests in physical activity, public health, behaviour change, research methodology, or intervention evaluation research • Medical statisticians	• Policy makers • Chief Medical Officer (UK Government) • House of Lords: Science and Technology Select Committee • National Health Service
Results and Impact	• This research provides a detailed picture of a pragmatic community-level physical activity intervention in a rural setting. Other practitioners can use this model to develop their own community-level interventions. • This research demonstrates that pragmatic community-level interventions, such as DAV, can be evaluated in a cost-effective and rigorous manner.	• This research will add to the systematic review evidence base on the effectiveness of community-level physical activity interventions. • This research demonstrates that the stepped wedge cluster randomised trial design can be appropriate for evaluating community-level interventions.	• This research demonstrates that novel methods can be used to evaluate interventions in a rigorous and cost-effective manner – so more policy makers should encourage use of novel research methodology.
Recommen-dations	• Practitioners need to put as much focus into the increasing the population penetration of an intervention as to the implementation of intervention events.	• Future studies should consider using the stepped wedge design to evaluate physical activity interventions. • Future research should focus on how to achieve greater community penetration/ engagement in community-level physical activity interventions.	• Policy makers and funding bodies should ensure rigorous evaluation plans are in place before providing an intervention with funding, and to allow practitioners and researchers to invest as much resource in the promotion of an intervention as in the delivery of it.

The research study also demonstrated that it is possible to rigorously evaluate pragmatic community-level physical activity interventions using novel research techniques. This research study is also the first to use a stepped wedge cluster randomised controlled trial design to evaluate a community-level

physical activity intervention. The stepped wedge design was suitable for evaluating the Devon Active Villages intervention because it was by necessity delivered in waves, administered to all eligible communities in the population, and, once a community received the intervention, it was never fully taken away. It is anticipated that this research study will persuade other researchers and community health organisations to consider using novel techniques, such as the stepped wedge design, to rigorously evaluate community-level physical activity interventions. In the past, researchers may not have believed it was possible to rigorously evaluate complex and pragmatic community-level physical activity interventions. Researchers may have instead chosen weaker evaluation study designs, or perhaps not to conduct any form of evaluation. The results of this study will show other researchers that it is not only possible to evaluate pragmatic community-level physical activity interventions, but also that the evaluation can use a rigorous study design. It is hoped that this will lead to a rise in the number of good-quality evaluations of community-level physical activity interventions being reported in the literature, and thus producing a more comprehensive evidence base from which to draw conclusions.

This study also adds to the limited research available on physical activity in rural communities from England, and across the world. Rural communities face a unique set of challenges regarding their physical activity behaviour, and despite 20% of the English population living in non-urban dwellings (Craig et al., 2009), rural populations are generally understudied (Barnidge et al., 2013). It is important that community-level interventions are developed specifically to target the physical activity correlates that are unique to rural populations. Therefore, literature on rural populations needs to be readily available. The findings from the present study not only add to the research available on the correlates of

physical activity that are unique for rural populations, but also to the research available on evaluations of community-level physical activity interventions designed specifically for rural communities. Publishing the study protocol paper (Appendix G) allows other researchers to learn not only how we conducted the evaluation, but also comprehensive detail on how the intervention was implemented by Active Devon, information that would not otherwise be readily available. These findings are especially useful for researchers and community health organisations looking to develop and evaluate future community-level physical activity interventions tailored to rural communities.

Our findings from the cross-sectional study of physical activity correlates concurred with the literature on the consistent predictors of change in physical activity behaviour (e.g., health, physical activity habits, commitment to doing more physical activity; Bauman et al., 2012). However, physical activity social norms was found to be a correlate of physical activity, that is perhaps unique to rural populations. If there are physical activity factors that are unique to rural populations, such as social norms, this may provide rationale for new theories of behaviour change to be developed specifically for rural populations. Therefore, more research on rural communities is warranted to find consistent correlates and predictors of change in physical activity that are unique to rural populations.

The results of the evaluation study will also have implications for funding agencies, such as Sport England. Traditionally, Sport England-funded interventions have only been required to conduct minimal evaluation activities. For the Devon Active Villages intervention, Sport England only required Active Devon to report the number of individuals who registered as participants in intervention events. However, the registration numbers alone do not provide

any indication of whether the intervention was successful at changing physical activity prevalence at the community-level, or whether there has been any change in physical activity or any secondary outcomes. This provides Sport England with no indication of whether interventions are effective, and they may continue to fund interventions without knowing whether they are effective. The findings from the present study demonstrate that rigorous evaluations of Sport England funded community-level physical activity interventions can be undertaken on a small evaluation budget. Hopefully these findings will convince Sport England to include more rigorous evaluation criteria for community health organisations applying for intervention funding.

The majority of evaluations of community-level physical activity interventions have used repeated measures in a cohort of individuals. Following a cohort of individuals is useful for measuring change in physical activity behaviour in individuals over time. In contrast, evaluations that use repeated cross-sectional designs, where a different cross-section of the population is measured at each stage, are able to measure the community-level effect of an intervention. If a community-level physical activity intervention aims to have an influence on the community as a whole, using a repeated cross-sectional design may be the most effective way of measuring an intervention's effectiveness. The findings from the present research demonstrate how repeated cross-sectional designs can be used to effectively evaluate community-level physical activity interventions, and behaviour change at the community-level.

This research study has been presented to a variety of audiences, from academic researchers, commercial partners, community health organisations, and health promotion experts. The research study has also been written up into

three academic papers; one paper has been published in BMC Public Health (Appendix G), one paper has been published in the International Journal of Behavioral Nutrition and Physical Activity (Appendix K), and one paper has been submitted to the International Journal of Behavioral Nutrition and Physical Activity (Appendix L).

Throughout the intervention's delivery, feedback was given to Active Devon and the local delivery partners, in order to improve the implementation of the intervention in the later stages. The majority of feedback provided to Active Devon was qualitative, based on the reported awareness, participation, and opinions on the Devon Active Villages intervention (Appendix M, N, O, & P). A research summary was provided to Active Devon at the end of the project (Appendix Q). Throughout the project, I also responded to requests for statistics (e.g., proportion aware of the Devon Active Villages intervention from a particular region and stage) from Active Devon and the local delivery partners. I am currently working on producing a comprehensive evaluation report for Active Devon, detailing the main findings from the evaluation study, and the findings that are of specific interest to Active Devon. The evaluation information provides Active Devon with greater insight into the Devon Active Villages intervention, with more detail than they could have collected independently. This increased understanding of intervention effectiveness, will help Active Devon to adapt future interventions, based on the strengths and weaknesses of the Devon Active Villages intervention. These findings may also help Active Devon to attract more funding for community-level physical activity interventions in the future.

This Devon Active Villages Evaluation research project has also been shortlisted in the Exeter Impact Awards, in the 'Outstanding impact in health

and wellbeing' category, and for the 'Best postgraduate impact' award[1].

In this chapter, I described the methods used to collect and analyse the data in the main study evaluating the Devon Active Villages intervention. I presented and discussed the results in relation to other studies, and this study's own strengths and limitations. I also examined the concordance of reported participation in intervention events with the actual registration details from Active Devon. Finally, I discussed the impact of the evaluation study, in terms of both the research implications, and the implications for funders. In the final chapter I conclude the thesis as a whole, in relation to the findings from both the cross-sectional study of physical activity correlates, and the main Devon Active Villages evaluation study.

[1] The winners of the Exeter Impact Awards will be announced at an awards dinner on December 10th 2013.

CHAPTER 7.

Conclusions

In the previous chapter I presented the main study—evaluating the effectiveness of the Devon Active Villages intervention. Chapter 6 included information on the methods used to collect and analyse the data, the results from the regression analyses, as well as discussions about the findings, intervention concordance, and the impact of the research. In this chapter I conclude the findings from the entire PhD thesis, including the literature reviews, systematic reviews, cross-sectional study of physical activity correlates, and the stepped wedge evaluation study of the Devon Active Villages intervention.

Physical inactivity is one of the most important public health problems of the 21st century. In England, physical activity prevalence rates are low. Therefore, interventions to increase physical activity are crucial to improving population health. It is community-level physical activity interventions that have the potential to produce long-lasting benefits for the whole community. More rigorous evaluations of community-level physical activity interventions have been requested to further the theoretical understanding of what makes interventions successful.

Community-level physical activity interventions can be evaluated using various study designs. Randomised controlled trials are the most powerful design available, but may not be reproducible for evaluating pragmatic community-level interventions. Therefore, cluster randomised controlled trials, or more novel approaches, such as stepped wedge cluster randomised controlled trials, are more suitable for evaluating certain interventions. There is

a range of physical activity measurement methods available, varying by the degree of precision and ease of assessment. Criterion methods, such as doubly labelled water and indirect calorimetry, are only suitable for relatively small validation studies, whereas objective and self-reported measures can be used in considerably larger studies. Objective measures are generally associated with higher costs and increased researcher burden, and may, therefore, not be feasible for evaluation studies with a small budget. Self-report measures of physical activity are generally cheaper, easier to assess, and easier to conduct in larger studies, compared to objective measures.

There is limited research available on rural populations, especially from the United Kingdom. Regardless, it is clear that rural populations face a unique set of challenges associated with physical activity behaviour, compared with their urban counterparts.

From the systematic review of community-level physical activity interventions, it was clear that although numerous community-level physical activity interventions have been undertaken, very few have been evaluated and the results published. There was a lack of evaluations that used rigorous study designs, studies from the United Kingdom, and interventions delivered to rural communities. Less than half of the included studies found positive intervention effects for physical activity outcomes. Therefore, present evidence does not support the hypothesis that multi-component community-level interventions effectively increase population prevalence of physical activity in adults. The systematic review of physical activity correlates revealed that there is still limited research available from rural populations in the United Kingdom, despite numerous studies investigating the correlates of physical activity. A large number of correlates were associated with physical activity behaviour in one or

more of the included studies. However, many correlates had inconclusive associations with physical activity behaviour, making it difficult to form clear recommendations for the development of tailored community-level physical activity interventions. The correlates that appeared to be most consistently associated with physical activity behaviour were male gender, overweight/obesity (inversely), health, self-efficacy, social support, and barriers to regular activity (inversely).

Based on the literature and systematic reviews, two studies were conducted as part of this PhD thesis: a cross-sectional study of physical activity correlates, and an evaluation study of the Devon Active Villages community-level physical activity intervention. For the evaluation study, adults' physical activity (the primary outcome), and a range of secondary outcomes, were measured using postal surveys in a stepped wedge cluster randomised controlled trial. The cross-sectional study used data from the baseline stage of the evaluation study, to examine the correlates of physical activity behaviour in rural adults.

In the cross-sectional study of physical activity correlates, both individual and village-level predictors were included in the analysis. Gender, health, commitment to being more active, activity habits, social norms, and use of recreational facilities were revealed as the most consistent correlates of physical activity behaviour. Although most of the results were in line with previous research, this study did highlight some unique characteristics of the rural population. For instance, social norms may be a uniquely important factor for rural populations. Understanding the correlates that influence physical activity behaviour is important for the designing of effective physical activity

interventions, but generally the relationship between these correlates is complex and typically understudied, especially in rural populations.

One of the behavioural frameworks that the study correlates fit in with is the Social Cognitive Theory (Bandura, 1986). The Social Cognitive Theory was built on an understanding of the interaction that occurs between an individual and their environment. The Social Cognitive Theory is one of the most widely applied theories in health promotion because it addresses both the underlying determinants of health behaviour and methods of promoting change (Nutbeam, Harris, & Wise, 2010).

One of the key principles of the Social Cognitive Theory is ‘reciprocal determinism’, which describes the way in which an individual, their environment, and their behaviour continuously interact and influence each other (Bandura, 1986). An understanding of this interaction and of the way in which the modification of social norms can affect behaviour offers an important insight into how behaviour can be modified through health promotion interventions. For example, seeking to modify social norms regarding smoking has been shown to be a powerful way of promoting smoking cessation among adults (Nutbeam et al., 2010). Similarly, our study found that social norms were strongly associated with physical activity behaviour among rural adults.

Another important concept in the Social Cognitive Theory is self-efficacy, which is the belief in one’s own ability to successfully perform a behaviour (Bandura, 1997). According to Bandura, self-efficacy is the most important prerequisite for behaviour change, and will affect how much effort is put into a task and the outcome of that task (Bandura, 1997). In the present research self-efficacy formed part of the ‘commitment to do more physical activity’ variable,

which was found to be strongly associated with physical activity behaviour, and so fits in well with this behavioural framework.

In the evaluation study, an experimental approach to the design and evaluation of the Devon Active Villages programme showed no evidence that the intervention increased the prevalence of physical activity within the villages, and only weak evidence of an increase in physical activity level. However, the intervention did lead to an increase in physical activity habits. The evaluation penetration data highlighted that very few residents were even aware of or participated in the programme. This study highlights that evaluating population-level interventions is challenging but not impossible. Indeed, better understanding of the effectiveness of such interventions will only be achieved if more community-level interventions, which continue to be funded, are evaluated with more robust research designs.

I recommend that future evaluation studies consider the use of the stepped wedge cluster randomised trial design for evaluating health interventions, especially for community-level physical activity interventions. Using novel approaches, such as the stepped wedge design, may help overcome the issue of evaluating pragmatic community-level interventions in a rigorous, ethical, and cost-effective manner. Additionally, I recommend that more rigorous evaluations of community-level physical activity interventions are needed to help understand what works in altering population prevalence. In order to improve validity and reliability, these intervention evaluations should include objective measurements (e.g., accelerometry data) and multiple data collection time-points. Finally, I believe more research is warranted on how to achieve greater community penetration/engagement in community-level physical activity interventions. Future interventions need to both deliver effective

interventions, and achieve a high level of reach to achieve changes in population prevalence.

In order to achieve high levels of population penetration, I would recommend that researchers aim to first increase awareness of interventions among the target community. In order to increase intervention awareness, strategies could include mailing information leaflets to all households in the target community, or using media (e.g., radio, newspaper, community newsletter, and possibly television) to promote intervention events. However, these strategies can be costly to implement and need to ensure that the right audience is reached in order for such strategies to be effective. A cheaper alternative would be to use local community ‘champions’ to promote the intervention. Using local volunteers to champion an intervention should help the intervention be viewed as one that is being delivered with involvement and blessing from the target community, rather than an intervention that is being conducted on a community by ‘outsiders’. However, it is not always easy to find an appropriate person in each community to promote the intervention.

APPENDICES

Appendix A. Devon Active Villages 'Project Plan'

Devon Active Villages Project Plan

Dec 2009

Devon County Council

active devon

Contents

Acknowledgements

Grateful thanks are extended to the following partners and stakeholders who have fully supported and contributed to the development of the Devon Active Villages programme and whose ongoing support will be a critical ingredient in our achievement of the desired outcomes for Devon's rural communities:

- 5x30
- Community Council for Devon
- Devon County Council
- Devon Extended Services In and Around Schools
- Devon Learning and Development Partnership
- Devon Playing Fields Association
- Devon Rural Network
- East Devon School Sport Partnership
- Exeter College
- North Devon Council
- Okehampton Community Recreation Association
- South Hams District Council
- Team Devon
- Teignbridge District Council
- Tone Leisure
- Torridge District Council
- West Devon Borough Council

- British Cycling
- British Orienteering
- England & Wales Cricket Board
- England Athletics
- England Badminton
- England Hockey
- England Netball
- England Volleyball
- English Table Tennis Association
- Exercise, Movement and Dance Partnership
- Lawn Tennis Association
- Rugby Football Union
- The Football Association
- UK Ultimate

Introduction

The Devon Active Villages Concept

Devon Active Villages is a development programme which supports village communities in Devon to provide long term sustainable sports participation opportunities. The Active Villages concept is positioned in the introductory/informal sport segment of the market and is aimed at getting people into sports participation. Its main purpose is to offer people of all ages opportunities to experience the fun of sport. It is designed neither as a specific 'public health' initiative to deliver health based physical activity interventions nor a 'sports excellence' programme aimed at identifying talented performers who wish to engage in serious competition. Although both of these may be incidental outcomes, the main aim is to offer people opportunities to experience the fun of sport and in so doing build a lifelong love of being active and healthy. The project therefore principally addresses Sport England's GROW objective.

The project will work by:

1. Identifying what opportunities each local community wants
2. Providing support to "kick start" activities
3. Supporting people within their communities to sustain the opportunities

Whilst the primary objective is to improve people's rates of participation in physical activity and sport there will also be a number of other outcomes such as developing strong, sustainable and cohesive communities, improving health and reducing health inequalities, improving the life chances and focussing the energies of children and young people, creating safer communities by reducing anti-social behaviour and increasing skills and prosperity.

The programme is targeted at parish communities with between 500 and 2000 residents (see list of target communities at Appendix 1) but it is anticipated there will also be a broader impact on those people living in smaller surrounding communities. Approximately 157,000 Devonians live in the parish communities which the programme intends to target. Of these 131,000 are aged 15+ years.

The Active Villages programme has an offer for people of all ages from primary school children to adults. It is built around:

- Specialist support to help communities identify those opportunities they would like and would be most appropriate.
- Initial funding support to help in the establishment of activities (eg towards equipment, facilities, training etc)
- Training programmes provided for volunteers within each community to enable them to sustain activities.

- Initial promotion and provision of activities for a 12 week period – the Active Villages programme could typically comprise an after school club aimed at primary school children, a youth sports offer for young people of Secondary School age and then an adults' programme
- Regular mentoring visits to support communities' volunteers
- Access to bespoke 'self help' resources such as promotional support and materials, on-line tool kits and activity starter packs.
- Potential links to 2012 Olympic Legacy programmes

Whilst Active Devon is uniquely placed to oversee the strategic roll out and co-ordination of the programme it is vital that the programme reflects the diversity that exists within Devon's districts and village communities. Accordingly the most important principle is that empowerment to deliver the most appropriate local solutions in the highest priority communities is devolved locally through Active Devon's network of local partners. Whilst there is a need to satisfy external funding agencies that consistent outcomes will be achieved across the area the solutions identified locally are likely to differ depending on the prevailing local circumstances.

Devon's established network of Community Physical Activity and Sports Networks will be used to ensure that key local partners such as local authorities, school sport partnerships, voluntary sports clubs, other voluntary sector agencies and PCTs are fully involved with the successful delivery of the scheme. Active Devon can also use its unique position to broker further support from relevant National and Regional agencies such as National Governing Bodies of Sport.

Active Devon is confident that, by working with local partners and 'supporting' rather than just 'providing', the delivery model proposed will help to lay the foundations of sustained community activity. We consider that in working with village communities, where there is traditionally a strong 'sense of community' and ethos of self help, the likelihood of sustainability will be further enhanced. This is strengthened by the fact that all age groups within the community can be actively engaged.

The project represents an ambitious collaboration between a wide range of key partners. It is principally funded by Devon County Council, Sport England and Active Devon and will be strategically co-ordinated by Active Devon. National Governing Bodies and local stakeholders throughout Devon have contributed to the development of the project and will play a critical role in successful delivery of local opportunities.

The programme is planned to last in the first instance for 3.5 years from April 2010 to September 2013.

This project plan divides the project roll out into seven 6 month periods between those dates. Project delivery timetable, finance, marketing and monitoring, evaluation and research proposals are summarised for the full project period. A detailed delivery plan is included for the first three periods from April 2010 to September 2011. The detailed delivery plan also includes a number of 'prior to project start' actions which are essential pre-cursors to successful implementation.

Detailed Delivery Plan – April 2010 to September 2011

Project Area 1: Central Project Co-ordination **Lead by:** HoD (then DAVM)		**Resources:**
Outcome: Effective strategic programme management structure is in place		**£85,443**
Key Actions:	**Milestone:**	**Date:**
Recruitment of project staff - Strategic co-ordination and implementation of Devon Active Villages will be the responsibility of Active Devon and the programme budget includes costs for two posts dedicated to the project. Active Devon will be the employer of central staff. A **Development Manager** (0.8 FTE) will be appointed who will be the lead officer for the programme (Devon Active Villages Manager – DAVM). The post holder will oversee all aspects of project planning, implementation, monitoring and evaluation. Project support will be provided by a **Sport Development Assistant** (0.5 FTE) post. Gradings for the two posts are Grade G for Development Manager and Grade B for Sports Development Assistant. Salaries are c. £33K and £15K full time equivalent respectively. In addition, in order to ensure that pre-delivery planning is fully effective and to support new project staff into post a 3 month full time secondment is planned to start as soon as possible upon notification of award.	Without prejudice permission to commence recruitment secured Recruitment advertisement placed Selection interview conducted Secondment arrangements confirmed	By 8.1.2010 By 15.1.2010 By 1.3.2010 Jan 2010
Establishment of project management group – A project management group (PMG) will be established to contribute to overall strategic management of the programme. The group will comprise representatives from the following partner agencies: • Active Devon (Senior Manager, DAVM and Board Member) • Devon County Council • Sport England • Community Council of Devon • 5x30 • Devon Learning and Development Partnership • Community Physical Activity and Sports Partnerships (1 rep from each of the 7 CPASNs) • Other appropriate representatives as required The project management group will be serviced by Active Devon and will meet formally on a quarterly basis. It will operate within an agreed terms of reference	Membership of PMG confirmed First meeting of PMG Terms of Reference agreed Quarterly meetings held	Jan 2010 Apr 2010 Apr 2010 Ongoing from Apr 10
Service agreements (SAs)– Delivery of project interventions will be undertaken by local partners identified in conjunction with the respective Community Physical Activity and Sport Network. Delivery arrangements will rest upon formal service agreements between the respective partner and Active Devon. Assessment of fitness for purpose and suitability of delivery staff will take place prior to confirmation of SAs	Delivery agencies and personnel confirmed SAs in place for pilot phase SAs in place for phase 1	Mar 2010 Apr 2010 Dec 2010

Project Area 2: Support Resources **Lead by:** HoD (then DAVM) **Supported by:** External expert partners and Local Delivery Partners (LDPs)		**Resources:**
Outcome: Appropriate resources are in place to support and add value to the work of local delivery partners and assist in consistent provision across the programme		**£12,500**
Key Actions	**Milestones:**	**Date:**
Development Support Toolkit (DST) – The provision of expert sports development support to each community will be delivered under service agreement by various local partner agencies. Local partners will need to demonstrate that the personnel conducting this work have proven knowledge and experience but even so it is important that consistent familiarisation is provided to ensure consistency of outcomes across the programme. The Development Support Toolkit will consist of two elements: 1. Induction / familiarisation training for all development workers involved in the programme 2. Development support pack which will include details of support available, self-help resources to provide to communities, scheme minimum operating standards, details of progression routes available in the relevant locality and an outline framework for provision of sports development support within the programme The Development Support Toolkit will be bespoke for the Devon Active Villages programme and as well as pulling together commonly available best practice resources, experts from Local Delivery Partners will be invited to contribute to its development. A project team will be appointed on a 'task and finish' basis to develop the resource.	Project team appointed DST produced Familiarisation complete DST reviewed and revised	Feb 2010 May 2010 May 2010 Sep 2010
Coach Training/Delivery Resources – The often isolated nature of the programme's target communities together with the small population sizes means that provision of specialist sports specific coaching programmes is unlikely to be appropriate in most cases. Delivery will focus more generically on multi-skills, multi-sport and fitness/exercise. Furthermore the supply of coaches in the broad range of sports to allow for complete coverage across the dispersed rural communities (eg each community having access to qualified coaches in c.15 sports) is not a realistic short to medium term ambition. Notwithstanding this Devon has a strong track record in Coach Development and a significant and growing base of coaches qualified to NGB level 2 standard. The solution which has been consulted upon with NGB partners is the concept of cross skilling existing level 2 coaches with multi-sport training so that they can apply their existing 'how to coach' skills to a broader range of 'what to coach' content. Of the fifteen NGBs consulted as part of this project all were supportive of this approach and 11 considered that their sport would fit well within such a delivery programme. The aim is not, for example, to ask a rugby coach to coach the technical intricacies of cricket, rather the outcome will be coaches who are able to deliver safe, effective and engaging opportunities for participants to play a range of different sports (most often in simplified / conditioned versions of the game) and then to signpost them to further opportunities (eg local club) if they wish to progress their involvement in a particular sport. Existing training programmes will be used where appropriate eg scUK multi skills. There is however a need to provide coaches with a multi-sports training programme. Discussions have taken place with Exeter College (further education) who will lead the development of a multi-sport training module, aimed at existing level 2 coaches, which will be accredited by an external awarding body. A project team will be appointed on a 'task and finish' basis to develop the resource. NGBs consulted are very supportive and have indicated that they will be prepared to contribute to the course development and/or will provide resource cards etc.	Project team appointed Bespoke training package designed Bespoke training accredited Coaches trained Training reviewed and revised	Jan 2010 Apr 2010 Jun 2010 Jul 2010 Jan 2011

Project Area 3: Coach Workforce **Lead by:** HoD (then DAVM) **Supported by:** External expert partners and Local Delivery Partners	**Target:**	**Resources:**
Outcome: Sufficient numbers of coaches with the requisite delivery skills and knowledge are in place to enable local delivery partners to implement the programme effectively	Pilot phase 12 coaches Phase 1 20 coaches	**£4,750**
Key Actions	**Milestones:**	**Date:**
Coach Recruitment - As indicated above there is a strong base of coaches in Devon qualified to NGB level 2 standard or above. Between Active Devon and our local delivery partners there is significant intelligence about local coaches who would be willing and appropriate to be involved in the programme. Furthermore NGBs have indicated that they will also be able to support the recruitment of coaches. Coaches working on the programme will be recruited via a formal application and recruitment process and will undergo pre-employment checks in line with DCC Recruitment Standards. In addition to qualified level 2 coaches who will lead sessions the intention is to work through our network of education partners, in particular in the FE and HE sector to enable placements for those students on sports coaching courses to be linked to the programme. These coaches will be deployed on a voluntary basis and act as assistant coaches.	Pilot phase Recruitment advertisement Selection complete Phase 1 Recruitment advertisement Selection complete Proactive engagement with HEIs/FEIs	 Apr 2010 May 2010 Nov 2010 Jan 2011 Apr 2010
Coach Development – Once recruited, coaches will receive a formal induction to familiarise them with the programme and operational requirements. In addition they will receive the cross skilling training package as described in Project Area 2 above.	Induction and skills training completed Pilot Phase Phase 1	 Jul 2010 Mar 2011

Project Area 4: Activity Delivery **Lead: DAVM and District CPASNs**	**Target:**	**Resources:**
Outcome: - Increased levels of participation in sport from people living in rural communities in Devon - Plus, following pilot phase, effectiveness of planned delivery interventions assessed	**Participants:** **5-16** - 1676 **17-19** - 241 **20+** - 1612 **Total - 3529**	**£275,048**

Delivery Partners:	[1]**Target Communities:** (**District** – Communities)
Whilst the programme enables all target communities to access a consistent package of support, local delivery of activity interventions will be achieved through a range of partner agencies depending on local circumstances. This is summarised as follows: • **East Devon** – East Devon District Council has no Sports Development Unit. Activity will be delivered on behalf of the Active East Devon CPASN through a partnership between East Devon School Sport Partnership and 5x30. • **Mid Devon** - Mid Devon District Council has no Sports Development Unit. Activity will be delivered on behalf of the Active Mid Devon CPASN through a partnership between Mid Devon District Council and 5x30. • **North Devon** – Activity will be delivered on behalf of the Active North Devon CPASN by North Devon Council. • **South Hams** - Activity will be delivered on behalf of the Active South Hams CPASN through a partnership between South Hams District Council and Tone Leisure. • **Teignbridge** - Activity will be delivered on behalf of the Active Teignbridge CPASN by Teignbridge District Council. • **Torridge** - Activity will be delivered on behalf of the Active Torridge CPASN by Torridge District Council. • **West Devon** - Activity will be delivered on behalf of the Active West Devon CPASN by West Devon Borough Council and Okehampton Community Recreation Association. As referenced in the Project Area 1, local delivery of activity interventions will be managed through the mechanism of Service Agreements. This is a proven mechanism and based entirely on the model through which Active Devon has managed delivery of the highly successful Sport Unlimited programme in the county.	**Pilot Phase – 15 communities** **East Devon** - Lympstone and Feniton **Mid Devon** - Silverton and Bampton **North Devon** - Landkey and Lynton & Lynmouth **South Hams** - Salcombe, Shaugh Prior and Modbury **Teignbridge** - Starcross and Moretonhampstead **Torridge** - Bridgerule and Dolton **West Devon** - North Tawton and Hatherleigh **Phase 1 – 35 communities** **East Devon** - Whimple, Uplyme, Dunkeswell, Beer, Rockbeare and Kilmington **Mid Devon** - Halberton, Sandford, Copplestone and Sampford Peverell **North Devon** - Witheridge, Mortehoe, Heanton Punchardon, Georgeham and Chulmleigh **South Hams** - Ugborough, Stokenham, Newton & Noss, Brixton, Harberton, Stoke Gabriel and Sparkwell **Teignbridge** - Hennock, Shaldon, Abbotskerswell, Tedburn St. Mary and Kenton **Torridge** - Hartland, Winkleigh, Woolfardisworthy and Bradworthy **West Devon** - Chagford, South Tawton, Lifton, Dartmoor Forest **Phase 2 – 35 communities** To be confirmed by December 2010 **Phase 3 and 4 – 70 communities** To be confirmed as part of September 2011 to August 2012 delivery plan.

[1] *Map showing location of proposed Target Communities for Pilot Phase and Phase 1 can be found at Appendix 2*

Project Area 4: Activity Delivery (cont'd)		
Key Actions:	**Milestone:**	**Date:**
Specialist Development Support – Provision of specialist sports development adviser to undertake engagement and consultation work with each community aimed at identifying what activities are wanted, can practically be provided and would be most effective. Outcomes of this work will be (a) to identify the nature of the activity programme which should be delivered within the community and (b) to agree a plan which addresses ongoing sustainability of activities eg is start up equipment required, is training of local volunteers required, what other support may be required? All deliverers will receive induction training about the programme and will work through a standard engagement process to ensure consistency. A further outcome of the pilot phase will be a review and assessment of effectiveness of these processes and supporting resources.	Pilot Phase 15 communities Phase 1 35 communities Phase 2 35 Communities	May-Jul 2010 Jan-Apr 2011 Jun-Sep 2011
Sports Activity Programme – Provision of intensive block of weekly sports coaching sessions to help kick start activity. Activity will be tailored to the needs of each community but typically will include separate sessions targeted at different age groups as follows: **Primary school** – 1 hour after school club on school site, multi-skills focus. **Secondary school 12-15** – 1hour twilight session, multi-sport focused. Delivered in the village community after return of secondary school bus drop offs to address the issue of lack of access to after school clubs for secondary students who rely on school transport **Adult 16+** – 1 hour evening session, fitness and exercise based. 1.5 hour multi-sport based This stage of the programme will directly contribute to the overall programme outcome of increased levels of participation in sport from people living in rural communities in Devon.	Pilot Phase 15 communities Phase 1 35 communities	Sep-Dec 2010 Apr-Jul 2011
Follow up support – Provision of follow up mentoring visits to support sustainability of activities. This will be tailored to the needs of each community and may involve for example, hands on coach mentoring support to newly trained volunteers in the community and/or further development support to help communities organise sustainable regular activity sessions or clubs. This phase will last for approximately nine months after the provision of initial intensive activity programme. The outcome of this work will be the establishment of sustainable participation opportunities.	Pilot Phase 15 communities Phase 1 35 communities	Dec 2010- Sep 2011 Commence Jul 2011

Since the original submission of the project in June 2009, and in response to further consultation conducted as part of the stage 2 project development, Active Devon is keen to extend the scope and value of the project so as to maximise the return on investment. There are two broad areas described fully in the tables below:

- **4+ Extended Activity Delivery** seeks to broaden the community offer so that it better encompasses links to sports which fit less easily into the Multi-Sport model. Specifically this includes cycling, running and exercise/movement/dance
- **4++ Bringing the Legacy to Life** seeks to tangibly and practically link the programme to the London 2012 legacy and to use the profile of the Olympic and Paralympic games to promote more participation in sport

Both these proposals can be considered as extensions to the programme and non-inclusion would not damage the effectiveness and relevance of the core programme as described within this project plan. However we genuinely believe that if included they would add real impact and value to the Devon Active Villages programme, both directly in terms of participation and contribution to 'grow' but also in further enhancing the strategic relevance of the programme and buy in from wider partners.

Project Area 4+: Extended Activity Delivery **Lead: DAVM and District CPASNs**	**Target:**	**Resources:**
Outcome: - Increased levels of participation in sport from people living in rural communities in Devon	**Additonal Participants:** **17-19** - 71 **20+** - 474 **Total - 545**	**£45,735** (total over 3.5 yrs)
Background and Rationale: Extensive consultation has taken place with NGBs (as referenced in PA2 Resource Development). Whilst the majority of sports are supportive of and consider they will fit well within the proposed generic multi-skills / multi-sports modes of delivery there are three which fit less easily. These are cycling, exercise/movement/dance and athletics (specifically running). A common issue is around specialised training/CPD within these sports. They are likely to be activities which are very appropriate for delivery in village settings and thus we are proposing an extension to the funding package to be able to more fully encompass these sports.		
Key Actions:	**Milestone:**	**Date:**
Extending start-up support – to be phased in line with the Development Support referenced in **PA4 Activity Delivery**, additional resources would be made available to communities to support the costs of sports specific volunteer training. In particular this could include specialised EMD fitness instructor courses (to be identified and provided on a cross-community basis), Run in England run leader training and British Cycling Ride Leader training (on- or off-road as appropriate). Whilst all three are very relevant there are particularly strong wider strategic benefits for cycling where the transport department of Devon County Council has announced major investment in cycling in Devon. There is potential for Bikeability (cycling competence training) to be rolled out countywide, where it is currently focused on the city of Exeter, and there is a genuine opportunity to enhance links between 'everyday' cycling and 'sport' cycling.	Pilot Phase 15 communities Phase 1 35 communities Phase 2 35 Communities	May-Jul 2010 Jan-Apr 2011 Jun-Sep 2011

Project Area 4++: Bringing the Legacy to Life **Lead: DAVM and District CPASNs**	**Target:**	**Resources:**
Outcome: - Increased levels of participation in sport from people living in rural communities in Devon - Increased enthusiasm for sport and increased connection with the London 2012 Olympic and Paralympic Games	**Additonal Participants:** **17-19** - 135 **20+** - 910 **Total - 1045**	**£44,225** (total over 3.5 yrs)
Background and Rationale: In less than 1000 days time the greatest sporting event on earth will take place in England. The London 2012 Olympic and Paralymic games will undoubtedly raise the profile of sport but there remains concern locally that insufficient emphasis is being directed towards securing the legacy. Devon Active Villages will roll out across a perfect timescale to coincide with the 2012 games. During the course of its stage 2 bid development Active Devon has consulted with key agencies concerned with the Olympics including Team Devon (the multi agency Olympic working group), Relays South West (HE sector regional organisation working on legacy projects through HEIs) and Devon Learning and Development Partnership (Schools advisory service delivering a 2012 schools legacy programme in Devon). All are genuinely excited about the potential that Active Villages has to complement and add value to their programmes which seek to secure a lasting Olypmic Legacy. In the timescales available it has not been possible to secure detailed commitments but Active Devon has verbal commitment of financial investment from within the Team Devon consortium, of officer time commitment from Relays and of co-operation and cross-branding/co-ordinated roll out with Devon LDP. The proposal therefore is that the Active Villages programme is expanded to include this dimension. Extending the proposed programme is a cost effective way of securing significant impact and Active Devon believes that such investment would also enhance the core programme, principally by raising profile amongst communities and key decision makers and also in securing deeper engagement with the programme from a broader range of people.		
Key Actions:	**Milestone:**	**Date:**
Active Village 'Legacy Days' – these events will be supported in each of the communities in which the Active Villages programme is rolled out. The focus will be a coming together of the community to celebrate the Olympics in the broadest sense. Typically it may include sporting and cultural activity. The Active Villages programme will support coaching staff during the event offering taster sessions and informal sporting opportunities and marketing / campaigning work will take place to promote activity happening as part of the Active Villages programme and also to spread the word about the benefits of an active lifestyle to those attendees who might not normally get involved in sport. An event organiser's toolkit will be developed and the establishment of the event in each community will be promoted during the Specialist Development Support phase of the Active Villages programme.	50 events held 105 events held	Apr-Sep 2011 Apr-Oct 2012
Inter Village Games – These events will have a sport focus and will represent the opportunity for communities to come together in a fun day of sport. Teams from around 10 communities will play each other in the various sports which they've participated in during the Active Villages programme. The focus will be social and informal though with the emphasis being on celebrating the games through sport. Every participant will receive a small keep sake to serve as a lasting reminder of the 2012 games. Once again the opportunity will be used to promote positive messages about active lifestyles. The events will foster community cohesion and also provide a focal point for participants in Active Villages programmes to work towards. The focus of these events will be for those 17+ since there are already a number of opportunities for 5-16 year olds to participate in competitive opportunities	Dates and venues confirmed for 16 events 16 events held	Oct 2011 Apr-Sep 2012

Summary Project Delivery Timetable – January 2010 to September 2013

The table below shows key milestones over the full 3.5 year roll out of the programme.

Green shading shows 18 month period covered by detailed delivery plan
Yellow shading shows activities proposed for extended delivery programme

Project Area ***Responsibility***	Jan-10	Feb-10	Mar-10	**Apr-10**	May-10	Jun-10	Jul-10	Aug-10	**Sep-10**	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	**Apr-11**	May-11	Jun-11	Jul-11	Aug-11	**Sep-11**	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	**Apr-12**	May-12	Jun-12	Jul-12	Aug-12	**Sep-12**	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sept-13
PA1 Central Project Co-ordination ***AD HOD then DAVM***	Recruitment of project staff			Project Man Group			Project Man Group			Project Man Group	Partner Network Event		Project Man Group			Project Man Group			Project Man Group			Project Man Group	Partner Network Event		Project Man Group			Project Man Group			Project Man Group			Project Man Group	Partner Network Event		Project Man Group			Project Man Group			Project Man Group		
		Finalise service agreements with delivery partners																																											
PA2 Support Resources ***External partners through AD HOD***			Develop support toolkit resources				Review and refine resources																																						
			Develop coach training resources										Review and refine coach resources																																
PA3 Coach workforce ***DAVM and LDPs***				Recruit and appoint pilot phase coaches			Pilot phase Coach Training							Coach Training					Coach Training							Coach Training						Coach Training														
									Recruitment of coaches ongoing throughout programme as per demand																																				
PA 4 Activity Delivery ***Appointed LDPs via service agreement***					Specialist Development support pilot phase (15 com'ties)								Specialist Development support phase 1 (35 communities)					Specialist Development support phase 2 (35 communities)							Specialist Development support phase 3 (35 communities)					Specialist Development support phase 4 (35 communities)															
									12 week activity interventions pilot phase (15 communities)							12 week activity interventions phase 1 (35 communities)					12 week activity interventions phase 2 (35 communities)						12 week activity interventions phase 3 (35 communities)					12 week activity interventions phase 4 (35 communities)													
												Follow up support pilot phase												Follow up support phase 2											Follow up support phase 4										
																			Follow up support phase 1												Follow up support phase 3														

Devon Active Villages – Project Plan

Project Area ***Responsibility***	Jan-10	Feb-10	Mar-10	**Apr-10**	May-10	Jun-10	Jul-10	Aug-10	**Sep-10**	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	**Apr-11**	May-11	Jun-11	Jul-11	Aug-11	**Sep-11**	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	**Apr-12**	May-12	Jun-12	Jul-12	Aug-12	**Sep-12**	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sept-13
PA4+ Extended Activity Delivery ***Appointed LDPs via service agreement***					Extended sport specific start up support pilot phase (15 com'ties)								Extended sport specific start up support phase 1 (35 communities)					Extended sport specific start up support phase 2 (35 communities)							Extended sport specific start up support phase 3 (35 communities)					Extended sport specific start up support phase 4 (35 communities)														
PA4++ Bringing the Legacy to Life ***Appointed LDPs via service agreement***						Finalise, promote and co-ordinate Active Village Legacy Days – Pilot and phase 1 (50 communities)												Finalise, promote and co-ordinate Active Village Legacy Days Phase 2, 3 and 4 (105 communities)																								
																Active Village Legacy Days Pilot and phase 1 (50 communities)												Active Village Legacy Days Phase 2, 3 and 4 (105 communities)																	
																Agree and finalise dates for Inter-Village Games (16 events)							Plan and co-ordinate Inter-Village Games (16 events)				Stage Inter-Village Games (16 events)																	
PA5 Marketing & Promotion ***AD MCM then DAVM***	Marketing plan finalised		Branding and promo resources designed		Branding and promotional resources piloted.					Branding and promotional resources reviewed and refined																																		
			PR / Promotional activity commenced			Ongoing Marketing support for overall programme and as agreed for delivery partners																																						
PA6 Monitoring, Evaluation & Research ***University of Exeter through HOD then DAVM***	Finalise and agree scope of long term research study		Recruit PHD research student				Research Preparation Inc: review of research articles and policy documents; finalising conceptual frame; collating and developing materials; designing interview schedules; liaising with partners; and visiting intervention sites.						Research study runs alongside project delivery with regular reporting milestones																							Final impact report produced							

Project Area 5 - Marketing and Promotion

Introduction

The marketing activity utilises a mixture of push and pull strategies to raise awareness of the programme and Active Devon brand to end users and to develop relationships with our Local Delivery Partners (LDPs), or in marketing terms our 'intermediaries', and stakeholders. These intermediaries include Community Physical Activity and Sport Networks, Local Authorities, School Sports Partnerships, voluntary sector agencies, Primary Care Trusts and Sports Clubs. The end goal is more people being more active in specific rural locations.

Communication Objectives

All marketing communications have the intention of reaching and influencing the target audience, in particular with Devon Active Villages, to change attitudes and motivate the end user to make a lifestyle change, for life.

The communication objectives are:

- Develop and maintain a brand identity
- Establish brand recognition and brand trust
- Raise awareness of Devon Active Villages Programme
- Increase the numbers of people from rural communities taking part in sport
- Empower LDPs to deliver high quality 'on-brand' activity sessions

Segmentation, Targeting and Positioning

Products / Services

There are certain characteristics that make marketing a service different to marketing a product. In the case of Devon Active Villages:

- **Intangibility & Ownership** - customers receive information making it hard for them to judge / value the service.
  - A customer recommendation system could be established
  - Certificate can be issued for achievement / attendance
  - Creation of a Devon Active Villages Club – uniting people with a common aim / experience
- **Inseparability & Heterogeneity** – it is hard to maintain consistency in service standards as services are delivered across the county.
  - Customer opinions to be sought
  - Strong customer service standards to be introduced
  - Branding Guidelines issued to all delivery networks

- **Perishability** – courses available at specific times only. Underbooking incurs wasted costs and overbooking produces customer disappointment.
    - Manage demand and supply using flexible promotion methods as required

Markets and Profiles of the Markets

Due to the delivery method of the programme, four clear target markets are emerging:

- Target Markets;
    1. Primary School Children
    2. Secondary School Children
    3. Adults (16+)
- Client publics
    4. LDPs (mentioned in section 1)

Both Sport England and Change4Life segmentation data will be utilised in tailoring marketing messages appropriately.

Positioning Strategy

A push strategy will be adopted, identifying and communicating with LDPs, promoting the initiative, training them and providing the tools to enable them to promote the programme in the heart of each village. In addition, Active Devon will manage a profile strategy that will stimulate and reinforce brand loyalty across all villages.

Marketing Strategy

Segmentation

The following segmentation characteristics will be utilised when developing marketing messages:

- Geographic – convenient access to activity sessions, activities suitable to location
- Demographic – sessions accessibly priced, fit with family commitments, tailored to age group
- Psychographic – something for the whole family/community, a place to meet people, improve health
- Benefit – recognising different customers have different motivation triggers

Branding

Management of the overall Active Devon family branding is required to build brand awareness in marketplace. Brand extension will be used to target this programme to specific customers, utilising customer trust in the Active Devon brand to introduce this programme directly to them. A strategic alliance will be created through effective co-branding of the overall programme with both Sport England and Devon County Council, thus transferring the positive associations associated with each organisation to the newly formed co-brand. The

marketing function will work with marketing representatives from each organisation to ensure relevant branding guidelines are adhered to. A well-executed co-branding strategy can be effective in exploiting good product performance, or in breaking into lucrative new markets previously unavailable or untapped by either or both of the co-branding partners. Internal marketing will also be a priority and integral to the marketing strategy to enable staff to promote the brand and will incorporate staff from all co-branded organisations.

Extended Marketing Mix

A more complex marketing mix must be used due to the intangibility of the services offered:

- Product and place: consultation with LDPs will shape the design of an intermediary delivery toolkit and what form the final product takes (web or paper-based). It is likely that the already successful Active Devon Extranet will provide the online presence of LDP support, but may need to undergo some development to meet LDP needs. On-going product development and text marketing will also determine usage and brand loyalty.
- People: investment will be made to ensure LDPs are able to offer high levels of service as this is key to successful market development. This will be achieved through internal emails, newsletters and presentations. In addition, emphasis will be placed on selection, training and support for intermediaries including monitoring of customer satisfaction levels.
- Physical Evidence: activity sessions will be held at a variety of locations, therefore setting, branding and ambience may be inconsistent. Consistency of branding will be provided by printed materials such as posters and flyers onsite.
- Promotion: positive case studies can raise brand awareness and convey key messages to a number of markets. Active Devon staff and LDPs will collate case studies on participants and feed into the marketing function for distribution to local press. In addition, participants will be encouraged to add a blog on their experience to a specified website as a low cost method of boosting Active Devon's profile. A dedicated website or micro-site will allow for effective segmentation of customers enabling tailored messages on direct mail to different segments i.e. for middle aged mums the motivator to participate will be predominantly about losing weight, where as for a newly retired person the motivator may be more about making new friends.

Marketing Tools

With the initiative being very much at the introduction stage of the product life cycle (PLC) and a limited launch budget, a through and below-the-line promotional approach will be adopted to introduce the initiative to LDPs and gain commitment from them to deliver activity sessions.

The communications will be highly targeted to all audiences (stakeholder, channel and consumer) and for LDPs, will predominantly involve direct marketing, although will include personal selling to grow existing Active Devon stakeholders into channel intermediaries and attract potential new LDPs.

In addition, a number of stakeholder events will be planned to bring together LDPs to share best practice, be informed of programme development, be reminded of brand practice and contribute to continual development and improvement of the programme.

The intention is to create a suite of marketing tools that can be accessed and used by the LDPs and access to a marketing consultant to effectively implement the tools.

With very specific consumer end users, personal selling and direct marketing will be the primary marketing tools and to a lesser extent, advertising, highlighting the value of participation in the programme, creating a community 'movement' that unites end users to a common aim and retaining loyalty once participating.

Collection of customer data will be vital to not only monitor the effectiveness of the programme, but also to provide consumers with ongoing motivation throughout the programme of activity sessions. Regular text and email motivational messages will be built into an ongoing customer relationship management system. It is envisaged that the majority of this will be carried out via a microsite attached to the existing Active Devon website.

Direct marketing and advertising in schools, in local community amenities (Post Office, Pub, mobile libraries) and door-drops will enable targeted marketing and offer good return on investment. Innovative mailers such as beer mats for pubs and interactive mailers for primary age children should attract consumers to complete the call to action.

Sales promotion will address retention rates by offering a 'reward card' sales promotion to encourage participants to sign up to the activity sessions and complete a retention target in return for rewards with participating retailers. This method has proven to be an extremely successful tool in the promotion of the Sport Unlimited programme and can be adapted to suit the requirements of the Devon Active Villages programme.

Implementation of the Devon Active Villages programme will coincide perfectly with the build up and staging of the London 2012 Olympic and Paralympic Games. This presents a unique opportunity and the increased profile of sport generated by the excitement and thrill of this World event will be fully utilised in promoting the Devon Active Villages programme. The focus on sport will be at a peak, with many people watching and learning new sports by following coverage of the Olympics and Paralympics and getting behind the British hopefuls. Part of the marketing plan will include an application for London 2012's Inspire Mark. Being able to use the Inspire Mark brand will provide kudos to the programme and will offer the end user a clear link from the Devon Active Villages programme to the London 2012 Olympic and Paralympic Games. The Olympics and Paralympics also bring out a sense of common purpose that we intend to tap into in order to enhance promotion of the programme in local communities.

Marketing Budget

The overall budget for marketing activity is £10,000 which will be profiled to reduce on a taper over the 3.5 years of the programme as the majority of the budget is needed initially to enable market penetration.

The majority of budgets should be dedicated to:

- Training staff
  - Setting customer service standards
  - Creating high quality highly skilled delivery staff
  - Creation of intermediary resources such as toolkits and online support
- Research and analysis
  - Customer perceptions / awareness
  - Customer satisfaction
  - Customer retention rates
- Communication / promotion mix
  - Printed material
  - Direct marketing (mailers & data lists)
  - Advertising
  - PR
  - Internet
  - Sales promotion (Reward Card)

Marketing Budget Breakdown

Tools	**Total Cost**
Internal Marketing	
Stakeholder events	2850.00
Inspire Mark application	Officer time
Intermediary Toolkit • Branding Guidelines • Delivery Templates • Marketing Checklist • Online marketing shop	 150.00 300.00 Officer time 250.00

Development of Password Extranet area	500.00

Direct Marketing	
Direct mail to existing intermediaries	Officer time
Direct mail to potential intermediaries and Reward Card partners	60.00
Consumer Data Lists	500.00
Mailout	500.00
Personal Selling	
Intermediary leaflet	183.00
Targeted Consumer Leaflets	615.00
Public Relations	
Editorials	Officer time
Advertising	
A4 & A3 Posters for community	330.00
Website	
Microsite development	3000.00
URL Purchase	60.00
Sales Promotion	
Reward Card	1150.00
TOTAL BUDGET REQUIRED:	**10448.00**

Implementation and Evaluation

Each participant will complete a registration process before participating in activity sessions. It is imperative that either an email or mail address be provided for each participant (with opt in/out facility) so that participants can be contacted for both ongoing motivation and also post activity programme evaluation.

It is anticipated as a minimum, participants will be monitored on the following:

- Activity levels prior to participation in Devon Active Villages programme.
- Number of sessions in an activity programme attended.
- Attitude to activity sessions.
- Activity at defined intervals after participation in initial activities programme.

Project Area 6 – Monitoring, Evaluation and Research

Monitoring and Evaluation

The project seeks impact on Sport England's strategic objective of 'Grow'.[2] The principle measure will therefore be the number of participants. The table below shows the target numbers of participants which the project will seek to attract. Note that this is a brand new project and therefore baselines are zero in each case.

	P1		P2		P3		P4		P5		P6		P7		
Participants	**Apr 10-Sep 10**	*Increment on period*	**Oct 10-Mar 11**	*Increment on period*	**Apr 11-Sep 11**	*Increment on period*	**Oct 11-Mar 12**	*Increment on period*	**Apr 12-Sep 12**	*Increment on period*	**Oct 12 - Mar 13**	*Increment on period*	**Apr 13 - Sep 13**	*Increment on period*	**Total**
20+ years	0	0	523	523	1612	1,089	2854	1,242	3422	568	4604	1,182	4824	220	**4824**
17 to 19 years	0	0	78	78	241	163	426	185	511	85	688	177	721	33	**721**
5 to 16 years	0	0	536	536	1676	1,140	2944	1,268	3561	617	4923	1,362	5143	220	**5143**
Cumulative	**0**		**1,137**		**3,529**		**6,224**		**7,494**		**10,215**		**10,688**		
Total		**0**		**1,137**		**2,392**		**2,695**		**1,270**		**2,721**		**473**	**10,688**

Target figures are based on the following assumptions:

- Participants aged 17 and over – 3% of the population of target communities to participate in the scheme with additional 1% of the population participating each year.
- Participants aged 5 to 16 – 16.7% (one in six) children from target communities to participate with 30% growth in the number of participants each year reflecting new entrants into the scheme.

[2] Sport England's strategic objective 'Grow' - One million people taking part in more sport and more children and young people taking part in five hours of PE and sport a week

Devon Active Villages – Project Plan

The detailed delivery plan includes two additional sections, PA4+ and PA4++ which propose an enhanced and extended programme to broaden and maximise the impact of the Devon Active Villages project and also cement links to the London 2012 Olympic and Paralympic Legacy. The table below provides revised target numbers of participants which the project will seek to attract by including these revised delivery programmes:

	P1		P2		P3		P4		P5		P6		P7		
Participants	**Apr 10-Sep 10**	*Increment on period*	**Oct 10-Mar 11**	*Increment on period*	**Apr 11-Sep 11**	*Increment on period*	**Oct 11-Mar 12**	*Increment on period*	**Apr 12-Sep 12**	*Increment on period*	**Oct 12 - Mar 13**	*Increment on period*	**Apr 13 - Sep 13**	*Increment on period*	**Total**
20+ years	0	0	715	715	2203	1,488	3703	1,500	4556	853	5878	1,322	6209	331	**6209**
17 to 19 years	0	0	107	107	329	222	553	224	680	127	878	198	927	49	**927**
5 to 16 years	0	0	536	536	1676	1,140	2944	1,268	3561	617	4923	1,362	5143	220	**5143**
Cumulative	**0**		**1,358**		**4,208**		**7,200**		**8,797**		**11,679**		**12,279**		
Total		**0**		**1,358**		**2,850**		**2,992**		**1,597**		**2,882**		**600**	**12,279**

Revised target figures are based on the following assumptions:

- Project Area 4+ Extended Activity Delivery will increase baseline engagement level of community by 0.4%
- Project Area 4++ Village Legacy Days will increase baseline engagement level of community by 0.7%
- Project Area 4++ Inter-Village Games will increase baseline engagement level of community by 0.4%
- Additional activities targeted at 17+ so no additional targets factored for 5-16 year olds

The final table below shows the additional target numbers of participants which the project will seek to attract by including these revised delivery programmes:

Participants	P1 Apr 10-Sep 10	*Increment on period*	P2 Oct 10-Mar 11	*Increment on period*	P3 Apr 11-Sep 11	*Increment on period*	P4 Oct 11-Mar 12	*Increment on period*	P5 Apr 12-Sep 12	*Increment on period*	P6 Oct 12 - Mar 13	*Increment on period*	P7 Apr 13 - Sep 13	*Increment on period*	Total
20+ years	0		192		591		849		1,133		1,273		1,383		
		0		192		399		258		284		140		110	**1383**
17 to 19 years	0		29		89		128		170		191		208		
		0		29		60		39		42		21		17	**207**
Cumulative	**0**		**221**		**680**		**977**		**1,303**		**1,464**		**1,591**		
Total		**0**		**221**		**459**		**297**		**326**		**161**		**127**	**1,591**

The key performance indicators will be measured through the gathering of participant registration data. Collection will be by various methods including:

- Individual participant registration forms for every person attending sessions
- Online registration scheme for participants to include a rewards card scheme
- Follow up participation surveys amongst participants at regular intervals
- Attendance registers
- Selective qualitative analysis work which may include before and after surveys, case studies and 1: 1 interviews

In addition to the participant data required by Sport England there are important local outcomes which are reflected in the Local Area Agreement (LAA) and focus on general rates of participation rather than number of people taking part in this project. The LAA uses data from the Active People survey to measure these. Unfortunately the Active People survey does not measure accurately at parish level and so a standard single question[3] will be used on initial registration forms and at intervals thereafter to estimate contribution of the programme towards these targets.

[3] **Single item question** - In the past 4 weeks, on how many days have you done 30 minutes sport and recreational physical activity including activities such as brisk walking or cycling when the effort was usually enough to raise your breathing rate? Please do not include gardening, DIY, housework or walking and cycling just to get from place to place, or any teaching, coaching or refereeing. Number of days (0 to 28)

Project Research Programme

In addition to the monitoring and evaluation work described above, the project will include a comprehensive PhD research study. This is the result of a successful application for a grant of £57,000 from University of Exeter / Economic and Social Research Council (ESRC). Active Devon considers the research programme to be a critical component of the programme as a whole since it represents a rare opportunity to objectively assess the impact of our work and it will also be framed in such a way to support an evidence based proposal for continuation of investment from wider partners after Sport England investment finishes. The research programme is outlined below:

Key Research Aim:

- To understand the impact of the 'Devon Active Villages' programme.

Objectives

- Identify success of programme in meeting its aim of greater participation.
- Identify and examine potential secondary outcomes of programme.
- Identify the 'why' and 'how' of the effectiveness of the programme.
- Identify and feedback best practice during programme implementation.

Methods:

- Large-scale questionnaire data (and potentially longitudinal data); In-depth interviews; and On-site visits.

Timeline: (if funding secured and student in post by July 2010)

July 2010 – Dec 2010	Literature reviews (inc. research articles and policy documents); finalising conceptual frame; collating and developing materials; designing interview schedules; liaising with partners; and visiting intervention sites.
Jan 2011 – Dec 2012	Data collection and analysis (inc. questionnaire and interview data, and current and archival participation data); training in quantitative and qualitative methods of inquiry; writing up of studies for publication; dissemination with Active Devon.
Jan 2013 – Jun 2013	Write-up of thesis; finalising feedback to Active Devon.

Outcomes:

- Academically-sound research, with dissemination via internationally-recognised journals and conferences.
- Results directly relevant to Active Devon, gaining from expertise from Sport Science and Business at University of Exeter.
- PhD student and academic supervisors will work closely with Active Devon to ensure that the research findings are disseminated widely to policy users: for example, via skills initiatives, training workshops, conferences, and in-house publications and newsletters.

Finance Plan – April 2010 to September 2013

		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	
		Apr 10 - Sep 10	Oct 10 - Mar 11	Apr 11 - Sep 11	Oct 11 - Mar 12	Apr 12 - Sep 12	Oct 12 - Mar 13	Apr 13 - Sep 13	*TOTAL*
Expenditure									
Coaches Fees		***0***	***26220***	***69278***	***82194***	***84660***	***84660***	***21800***	***368811***
Staffing - Coordination staff		**34990**	**22660**	**23793**	**23793**	**24982.7**	**24982.7**	**26231.8**	***181433***
Staffing - Development staff		**15000**	**35000**	**36050**	**36050**	**37132**	**0**	**0**	***159232***
Equipment		**10750**	**15750**	**18250**	**18250**	**18250**	**0**	**0**	***81250***
Facility Hire		**3750**	**6750**	**6250**	**6250**	**7250**	**1000**	**0**	***31250***
Promotion and Publicity		**4000**	**2845**	**907**	**900**	**900**	**496**	**400**	***10448***
Research		**5750**	**11500**	**11500**	**11500**	**11500**	**11500**	**5750**	***69000***
Support Resources		**4000**	**1000**	**1000**	**1000**	**700**	**300**	**0**	***8000***
Training		**11000**	**17500**	**18750**	**18750**	**18750**	**1250**	**0**	***86000***
TOTAL Expenditure		**89240**	**139225**	**185778**	**198687**	**204124**	**124188**	**54182**	***995424***
Income									
Income	DCC	60000	60000	60000	60000	60000	60000		*360000*
Income	Active Devon	6500	6500	6561	6561	6650	6650		*39422*
Income	University of Exeter /ESRC	4750	9500	9500	9500	9500	9500	4750	*57000*
TOTAL Income		***76000***	***71250***	***76061***	***76061***	***76150***	***76150***	***4750***	***456422***
Grant request		***13240***	***67975***	***109717***	***122626***	***127974***	***48038***	***49432***	***539002***

The detailed delivery plan includes two additional sections, PA4+ and PA4++ which propose an enhanced and extended programme to broaden and maximise the impact of the Devon Active Villages project and also cement links to the London 2012 Olympic and Paralympic Legacy. The table below gives the additional finance details associated with those extended aspects of the project:

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	
	Apr 10 - Sep 10	Oct 10 - Mar 11	Apr 11 - Sep 11	Oct 11 - Mar 12	Apr 12 - Sep 12	Oct 12 - Mar 13	Apr 13 - Sep 13	*TOTAL*
Additional Expenditure								
Coaches Fees	*0*	*0*	*5750*	*0*	*16555*	*0*	*0*	*22305*
Equipment	0	0	0	0	2560	0	0	*2560*
Facility Hire	0	0	500	0	3210	0	0	*3710*
Promotion and Publicity	0	0	1000	0	6900	0	0	*7900*
Support Resources	0	0	2500	0	5250	0	0	*7750*
Training	4425	10325	10325	10325	10325	0	0	*45725*
TOTAL Additional Expenditure	4425	10325	20075	10325	44800	0	0	*89950*
Additional Income								
Additional Partner income	2500	2500	5000	5000	15000			*30000*
TOTAL Income	*2500*	*2500*	*5000*	*5000*	*15000*	*0*	*0*	*30000*
Additional Grant request	*1925*	*7825*	*15075*	*5325*	*29800*	*0*	*0*	*59950*

Active Devon genuinely believes that if included these additional aspects would add real impact and value to the Devon Active Villages programme, both directly in terms of participation and contribution to 'grow' but also in further enhancing the strategic relevance of the programme and buy in from wider partners.

Glossary

AD *– Active Devon*
HOD *– Head of Development*
CPASN *– Community Physical Activity and Sport Network*
DAVM *– Devon Active Villages Manager*
DCC *– Devon County Council*
DST *– Development Support Toolkit*
EMD *– Exercise, Movement and Dance Partnership*
FE(i) *– Further Education (Institute)*
HE(i) *– Higher Education (Institute)*
LAA *– Local Area Agreement*
LDP *– Local Delivery Partner*
MCM *– Marketing & Communications Manager*
NGB *– National Governing Body*
PA *– Project Area*
PCT *– Primary Care Trust*
SA *– Service Agreement*
scUK *– Sports Coach UK*

Appendices

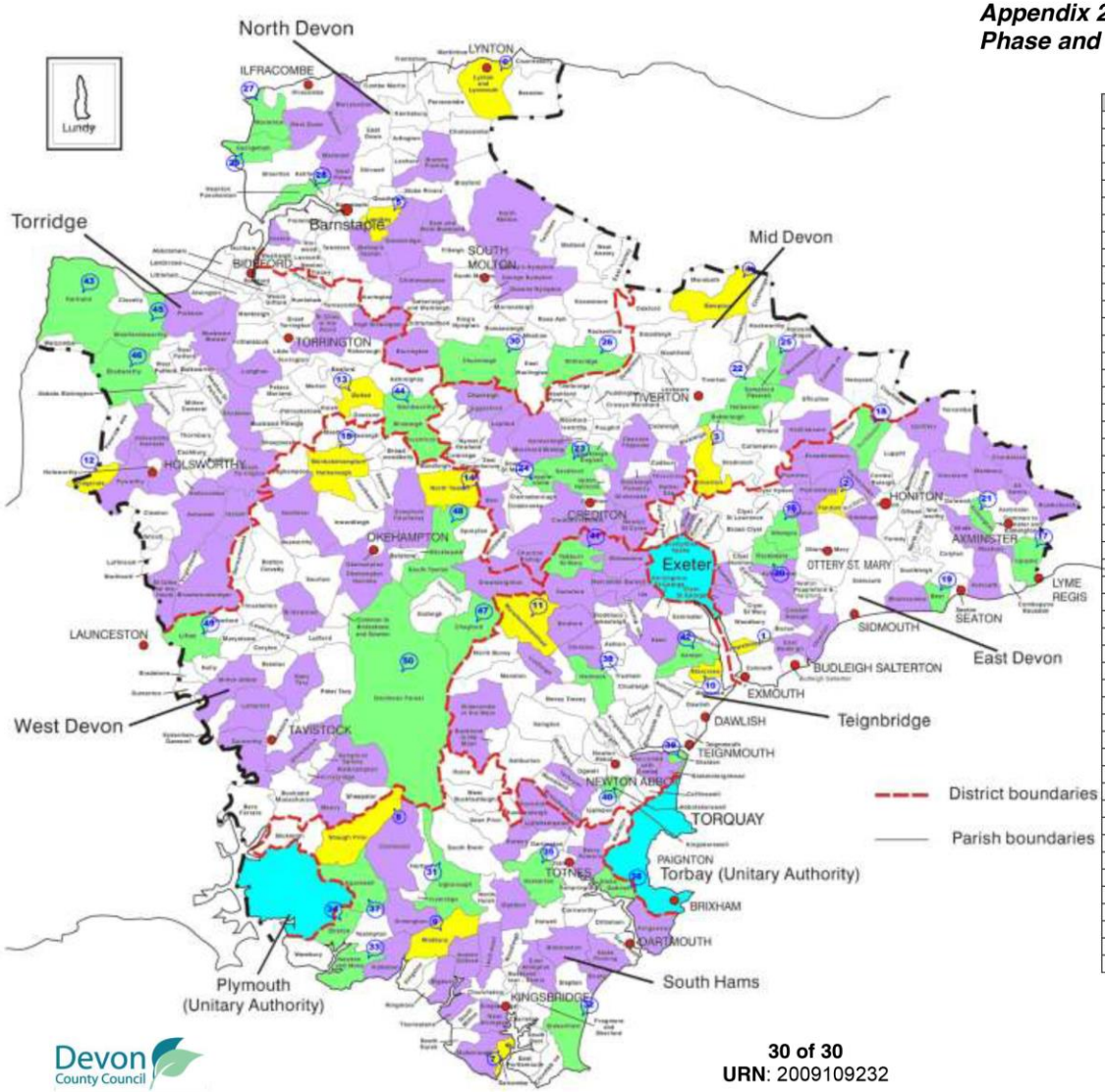
Appendix 1 – Devon Active Villages, target communities
Appendix 2 – Map showing location of Pilot Phase and Phase 1 communities

Appendix 1 – Devon Active Villages, target communities

District	Parish	Popn	Parish	Popn	Parish	Popn
East Devon	All Saints	**549**	Dunkeswell	**1,612**	Plymtree	**603**
East Devon	Awliscombe	**512**	East Budleigh	**811**	Rockbeare	**999**
East Devon	Axmouth	**532**	Feniton	**1,909**	Shute	**603**
East Devon	Aylesbeare	**609**	Gittisham	**573**	Sowton	**624**
East Devon	Beer	**1,362**	Hawkchurch	**525**	Stockland	**676**
East Devon	Branscombe	**517**	Kilmington	**848**	Stoke Canon	**663**
East Devon	Broadhembury	**692**	Lympstone	**1,962**	Talaton	**637**
East Devon	Chardstock	**839**	Membury	**535**	Uplyme	**1,616**
East Devon	Clyst St. George	**748**	Musbury	**547**	Upottery	**715**
East Devon	Clyst St. Mary	**631**	Otterton	**649**	Whimple	**1,759**
East Devon	Colaton Raleigh	**659**	Payhembury	**694**		
Mid Devon	Bampton	**1,726**	Crediton Hamlets	**1,274**	Newton St. Cyres	**889**
Mid Devon	Bow	**1,224**	Culmstock	**853**	Sampford Peverell	**1,310**
Mid Devon	Burlescombe	**1,030**	Halberton	**1,691**	Sandford	**1,372**
Mid Devon	Chawleigh	**639**	Kentisbeare	**942**	Shobrooke	**542**
Mid Devon	Cheriton Bishop	**768**	Lapford	**1,037**	Silverton	**2,032**
Mid Devon	Cheriton Fitzpaine	**901**	Morchard Bishop	**1,092**	Thorverton	**937**
Mid Devon	Copplestone	**1,336**				
North Devon	Berrynarbor	**907**	East and West Buckland	**552**	Marwood	**799**
North Devon	Bishop's Nympton	**994**	Georgeham	**1,582**	Mortehoe	**1,720**
North Devon	Bishop's Tawton	**1,292**	Heanton Punchardon	**1,660**	North Molton	**1,093**
North Devon	Bratton Fleming	**1,059**	Instow	**759**	Swimbridge	**1,001**
North Devon	Burrington	**504**	Landkey	**2,048**	West Down	**744**
North Devon	Chittlehampton	**888**	Lynton and Lynmouth	**1,753**	Witheridge	**1,348**
North Devon	Chulmleigh	**1,482**				

District		Parish	Popn		Parish	Popn		Parish	Popn
South Hams		Aveton Gifford	**918**		Holbeton	**632**		Sparkwell	**1,328**
South Hams		Berry Pomeroy	**1,035**		Kingswear	**1,260**		Staverton	**835**
South Hams		Bigbury	**551**		Loddiswell	**902**		Stoke Fleming	**1,046**
South Hams		Blackawton	**771**		Malborough	**999**		Stoke Gabriel	**1,350**
South Hams		Brixton	**1,413**		Modbury	**1,695**		Stokenham	**1,903**
South Hams		Cornwood	**1,116**		Newton and Noss	**1,840**		Strete	**538**
South Hams		Diptford	**578**		Rattery	**506**		Thurlestone	**862**
South Hams		East Allington	**735**		Salcombe	**1,953**		Ugborough	**1,845**
South Hams		Ermington	**878**		Shaugh Prior	**770**		West Alvington	**566**
South Hams		Harberton	**1,403**						
Teignbridge		Abbotskerswell	**1,582**		Hennock	**1,884**		Shaldon	**1,758**
Teignbridge		Bridford	**526**		Holcombe Burnell	**571**		Starcross	**1,840**
Teignbridge		Broadhempston	**742**		Ide	**539**		Stokeinteignhead	**777**
Teignbridge		Christow	**923**		Kenn	**1,123**		Tedburn St. Mary	**1,509**
Teignbridge		Denbury and Torbryan	**930**		Kenton	**1,180**		Whitestone	**751**
Teignbridge		Dunsford	**722**		Lustleigh	**638**		Widecombe in the Moor	**547**
Teignbridge		Haccombe with Combe	**795**		Moretonhampstead	**1,814**			
Torridge		Ashwater	**713**		Halwill	**969**		Pyworthy	**750**
Torridge		Black Torrington	**513**		Hartland	**1,715**		Shebbear	**1,022**
Torridge		Bradworthy	**1,133**		High Bickington	**887**		St. Giles in the Wood	**597**
Torridge		Bridgerule	**754**		Holsworthy Hamlets	**948**		St. Giles on the Heath	**677**
Torridge		Broadwoodwidger	**552**		Langtree	**828**		Winkleigh	**1,601**
Torridge		Buckland Brewer	**841**		Parkham	**840**		Woolfardisworthy	**1,172**
Torridge		Dolton	**887**						
West Devon		Bridestowe	**584**		Lamerton	**900**		Northlew	**724**
West Devon		Chagford	**1,498**		Lifton	**1,245**		Okehampton Hamlets	**561**
West Devon		Dartmoor Forest	**1,193**		Mary Tavy	**907**		Sampford Courtenay	**543**
West Devon		Drewsteignton	**891**		Meavy	**625**		South Tawton	**1,256**
West Devon		Gulworthy	**532**		Milton Abbot	**794**		Walkhampton	**856**
West Devon		Hatherleigh	**1,580**		North Tawton	**1,925**		Whitchurch	**522**

Appendix 2 – Map showing location of Pilot Phase and Phase 1 communities



	District	Parish	Popn	Phase
1	East Devon	Lympstone	1,962	Pilot
2	East Devon	Feniton	1,909	Pilot
3	Mid Devon	Silverton	2,032	Pilot
4	Mid Devon	Bampton	1,726	Pilot
5	North Devon	Landkey	2,048	Pilot
6	North Devon	Lynton and Lynmouth	1,753	Pilot
7	South Hams	Salcombe	1,953	Pilot
8	South Hams	Shaugh Prior	770	Pilot
9	South Hams	Modbury	1,350	Pilot
10	Teignbridge	Starcross	1,840	Pilot
11	Teignbridge	Moretonhampstead	1,814	Pilot
12	Torridge	Bridgerule	754	Pilot
13	Torridge	Dolton	887	Pilot
14	West Devon	North Tawton	1,925	Pilot
15	West Devon	Hatherleigh	1,580	Pilot
16	East Devon	Whimple	1,759	1
17	East Devon	Uplyme	1,616	1
18	East Devon	Dunkeswell	1,612	1
19	East Devon	Beer	1,362	1
20	East Devon	Rockbeare	1,691	1
21	East Devon	Kilmington	1,372	1
22	Mid Devon	Halberton	1,310	1
23	Mid Devon	Sandford	1,720	1
24	Mid Devon	Copplestone	1,660	1
25	Mid Devon	Sampford Peverell	1,582	1
26	North Devon	Witheridge	1,348	1
27	North Devon	Mortehoe	1,482	1
28	North Devon	Heanton Punchardon	1,840	1
29	North Devon	Georgeham	1,695	1
30	North Devon	Chulmleigh	1,413	1
31	South Hams	Ugborough	1,845	1
32	South Hams	Stokenham	1,903	1
33	South Hams	Newton and Noss	1,403	1
34	South Hams	Brixton	1,328	1
35	South Hams	Harberton	1,260	1
36	South Hams	Stoke Gabriel	1,884	1
37	South Hams	Sparkwell	1,758	1
38	Teignbridge	Hennock	1,509	1
39	Teignbridge	Shaldon	1,180	1
40	Teignbridge	Abbotskerswell	1,172	1
41	Teignbridge	Tedburn St. Mary	1,133	1
42	Teignbridge	Kenton	1,498	1
43	Torridge	Hartland	1,715	1
44	Torridge	Winkleigh	1,601	1
45	Torridge	Woolfardisworthy	1,256	1
46	Torridge	Bradworthy	1,245	1
47	West Devon	Chagford	848	1
48	West Devon	South Tawton	839	1
49	West Devon	Lifton	1,022	1
50	West Devon	Dartmoor Forest	969	1

Devon County Council

30 of 30
URN: 2009109232

active devon

Devon Active Villages

Engagement and Consultation Guide

Draft 2

25th May 2010

Active Devon has produced this toolkit in order to provide guidance for Local Delivery Partners on how to ensure that communities get fully involved in designing the activities and delivery of the Devon Active Villages Project.

In order for the project to be as effective as possible, where local need is accurately assessed and creatively addressed through planning, Local Delivery Partners will need to work with communities as closely as possible. This toolkit gives Local Delivery Partners information about best practice engagement processes.

The aim is to make sure that the engagement process is built on real partnerships, where communities begin to have 'citizen control'.

Engagement is part of a community development approach, where a community defines its own needs and can design, plan and provide solutions to address those needs.

What is engagement?
What are the benefits of an engagement process?
There is evidence that working in genuine partnership with communities can deliver:

- better quality and more responsive services;
- improved outcomes for the individual and the population;
- improvement in addressing inequalities;
- greater local ownership of services; and
- a better understanding of why and how services need to change and develop.

Engagement can also support project delivery in terms of generating value for money - you can improve the efficient use of resources if you can more accurately assess need and plan on that basis.

Engaging with communities offers repeated opportunities to develop more accurate needs assessment, which means more effective services which in turn means improved attendance at activities.

Engagement not only supports more transparent decision making it also encourages social inclusion because communities are sharing ownership of design of the programme and sharing responsibility for difficult decisions.

Some concerns you might have are:

- How do we make sure one group's voice doesn't dominate?
- What if groups are only self-interested and not able/willing to see the bigger picture?
- How do we know groups are as representative as they claim?
- How will we have the time to talk to all of these people?
- Our purpose is to bring our expertise – what added value can engagement bring?

There are ways to design the engagement so one group's voice does not dominate. There are simple facilitation methods that can help you ensure that all voices are

heard e.g. using small group work, tagging along to meetings of existing groups or just using established activities locally.

On one hand you *want* groups to be self-interested because it's their job to represent particular interests, you need their specialist knowledge. On the other hand, sharing the burden of decision-making is a benefit of the engagement process.

Communities do understand that there are limited resources and competition for those resources so they are ready for that conversation. This is an opportunity for people to share responsibility for the decisions made.

In terms of being representative the best thing to do is ask them. Groups have clear, extensive accountability structures and will be more than happy to show you how they work.

This toolkit does not say that you should talk to all of the people all of the time. Go back to your purpose, why you want to engage on a particular subject. People will only want to engage with you on an issue that's important to them.

What counts as meaningful engagement?

Meaningful engagement should happen as part of the process where the Local Delivery Partner works in equal partnership with communities to make delivery decisions.

Engagement is only meaningful if these experiences, ideas, thoughts and opinions actually have an impact on the decision-making of Local Delivery Partners and that users, communities can see evidence that this impact has occurred.

Over the last 5 to 10 years, individuals and communities have become more used to being consulted on matters of public policy. However, communities have often felt that their views have had little or no impact on the final decision. When their feedback has had an impact, no one has returned to explain how and to what degree. This disappointing process is what communities often refer to as 'consultation fatigue'.

Other barriers exist to meaningful engagement such as accessibility, rural isolation, language barriers and time constraints. The effective Local Delivery Partner will need to find creative ways to overcome these barriers.

Before you engage with communities you need to think about why you are doing it, who you need to engage with, how you might engage with them, what might be the barriers to the engagement and how you plan to overcome those barriers, what is the overall decision-making process of which the engagement is part and to what degree the engagement feedback will influence the final decision and how you intend to evaluate and monitor the success of the engagement, both in terms of process and content.

Introduction

Why you are doing it?

This Toolkit does not support the idea of talking to all of the people all of the time. There is no point in engagement unless it has a clear purpose. Local Delivery Partners must be clear why they want to engage with communities. The purpose of the engagement – the why - will then inform the how, i.e. how to design an effective and meaningful engagement so that the feedback gathered has an impact on decisions.

Communities will ask you why you are coming to talk to them and you will need to have a clear answer. This helps groups work out whether or not they want to engage with you, whether or not they are the relevant group to engage with and if so, how they might answer your questions.

You need to decide the purpose of the engagement before you do anything else.

Purpose helps you to define the outcomes: what do you want to get from the engagement?

The how of engagement will change based on what outcome you're trying to generate. Different kinds of conversations are needed for different kinds of outcomes.

Objectives: what are the objectives of the engagement?

For example:

- Population make up – who are your customers;
- Local needs assessment, current activities, take up and capacity;
- What other things do people want to take part in;
- Why do people take part or not.

You should agree the objectives before the process begins and let stakeholders know what they are. Your objectives may be challenged by stakeholders, so it is important to be clear how you will respond, perhaps by deciding whether or not the objectives can be changed.

It could be a good idea to consider producing an example template of what activities could be possible as a starting point. There is a need to make clear what can be achieved and what can't so as not ot raise expectations. This could include a timeline and demonstrate the support and follow up for sustainability of activities. You will almost certainly be asked how much money is available and what it can be used for.

Who are you?

You need to think about your role in the engagement process and what 'baggage' you might be bringing to the table.

- What is your role in the engagement process?

- How will the community perceive you?
- What is your history with the community?
- What existing relationships between Local Delivery Partners and communities will you be building on?

Who do you need to engage with?

In order to have a meaningful engagement process but also to ensure you get the outcome you want, you need to think carefully about who the key stakeholders are. Stakeholders are 'any person, organisations or agency affected by and involved in the issue, or having a specific interest in the issue under consultation'. [1]

1 **Rural Community Consultation Manual,** written for The Rural Community Network (NI) by The Worker's Educational Association and Community Technical Aid, 2002.

Some questions you might think of when working out who the key stakeholders are.

- Who will be impacted upon by this issue?
- Which sections of the population will be affected?
- Are all the stakeholders affected in the same way and/or to the same degree?
- If so, should the engagement process change for different groups?

You also need to find out what's going on inside a particular community.

- What are the internal dynamics?
- Are there any physical and material restraints on that community engaging with you?
- What are the relationships?
- Are there existing relationships between communities and existing physical activity and sport providers?
- How can you tap into these? E.g. end of cricket season – what do those players do in winter?

Using existing capacity, experience and partnerships

You do not need to reinvent the wheel. Local Delivery Partners will be able to work with various partnership structures that are already in place and rely on engagement experience and expertise that has been built up both within sport and physical activity and the community and voluntary sectors. School Sport Partnerships have carried out annual surveys to gather views of students on what they take part in and what they would like to take part in. Parish Plans exist across Devon's villages and most contain information about sport and recreation. These sources will need to have some verification to check validity, sample sizes and dates. Also worth making some enquiries before end of term to ensure schools based in villages have carried out surveys and to what extent.

Active Devon recommends finding out and using what is already known about people's views and experiences. Think about how you can build on existing relationships and get introductions into particular communities.

How you might engage with them?

- Do the relevant community groups have their own best practice guidelines on engagement, which must be adhered to?
- What does the community need in order to be fully involved?

Practicalities of engagement

- What information needs to be provided to communities prior to the engagement so that people are prepared? For example, briefing papers or visual aids.
- What relationships are needed both to initiate and support the engagement so Local Delivery Partners and communities get the most out of the process?
- Will the engagement be independently facilitated? If so, by whom? What are the costs of this?
- How do the users, carers and communities need to be resourced so that they can be fully involved?
- Is there enough time to carry out the engagement properly?
- Is there a budget for advertising, communication and promotion, venue hire, refreshments, transport, childcare, translation? Who will pay for these and organise them? Who will be impacted upon by this issue?

What level of involvement will you go for in the engagement process?

One reason that communities experience consultation fatigue is that policy consultation is often only a way for statutory organisations to present information on decisions that have already been made or to seek feedback on a pre-defined set of options, rather then being open to developing ideas and strategies in equal partnership.

'The Five levels of Community Engagement'[2] :

Infomation-giving
Consultation
Deciding together
Acting together
Supporting

2 The Five Levels of Community Engagement Per D. Wilcox: The Guide to Effective Participation

Different levels of involvement though may be more or less appropriate depending on at what point in the process you are engaging. There may be good reasons why you are choosing to consult rather than to 'act together', but the most important thing is to be upfront about which it is.

One benefit of deciding and acting together is sharing the burden of decision-making with communities, to involve them in the difficult decisions that you need to make.

To what degree will the engagement feedback influence the design of the programme?

Local Delivery Partners need to be clear as to how engagement with communities fits in with the overall decision-making process. Communities will want to know how their feedback will be taken account of, how it will impact on later decisions and what the later stages in the decision-making process are.

Active Devon recommends that you should embed a systematic approach to involvement that links corporate decision-making to the community. You should be honest about what can change, what is not negotiable – and the reasons why.

You need to come up with answers to the following questions

- What will happen to their feedback? Will the discussions be written up into a report and circulated to those who took part?
- How will their feedback have an impact on the decision that is being made? Will it count for the same as other stakeholders' opinions?
- Who will make the final decision?
- Who will return to the communities and tell them whether or not their feedback had an impact on the final decision, and if so, in what way and to what degree?

Returning to the communities with information on how their feedback had an impact on the final decision is crucial to maintain trust in the process. You are engaging with communities because you think that you will get a better outcome if you have an accurate and full understanding of local need and preferences. They are getting involved because they want to have an impact on the delivery programme decisions. Without evidence of that impact, people will fall away from the process disillusioned.

What might be the barriers to engagement and how will you overcome those barriers?

Support: we will identify and overcome any barriers to involvement.
Communities are experiencing 'consultation fatigue';
Cynicism - users, carers and communities think that their voice will have no impact;
Good engagement requires you to build trust between yourselves as the Local Delivery Partners and your communities; (Consider using activity as part of the engagement process. E.g village Fetes or other events. Get some action going on that they can join in with.
Resource and time constraints;
Engagement is about power – controlling it/sharing it.
Power relations are often ignored;
The Local Delivery Partner itself can be a barrier/challenge; and as the initiator of the engagement you are also a stakeholder and have a vested interest in the outcome of the consultation.

Local Delivery Partners may have current arrangements with community and voluntary sector organisations which act as intermediary bodies to help engage directly with communities. If these are informal relationships, give consideration to making them more formal if required so as to maintain focus and quality of information.

There are advantages and disadvantages to your attending these engagement events. Some advantages may be that:

- You can provide relevant information and expertise;
- People feel they have a direct line to the decision-makers and can influence the decision in the meaningful way;
- It demonstrates that you value the process and it holds you accountable to the communities.

Some disadvantages might be that where sensitive issues are at stake, the engagement event can be perceived as an opportunity to attack the initiators or to raise individual cases and gripes, and a constructive focus may be lost. Secondly, having Local Delivery Partners there, given their position of holders of information and power, can turn the process into a question and answer session on what the Local Delivery Partners is 'going to do', instead of a constructive process of developing fresh ideas on what the Local Delivery Partners 'could do'.

There may be other limitations placed on the scope of the engagement. For example, are there issues on which the decision has already been made, and so are not up for discussion?

It is best to be open about these limitations from the start, so the engagement can focus on what can be delivered.

When attempting to engage with communities it's important to make special effort to reach out to people whose voices are seldom heard. There are going to be some barriers that are particular to communities of identity or interest, for example, people with disabilities.

The Equality Commission looks at a series of planning issues when it comes to working with more marginalised communities. On information accessibility they note that 'the accessibility of the language and the format of information must be considered to ensure that there are no barriers to the consultation process.

Information should be available on request in accessible formats for example Braille, disc, and audiocassette and in minority languages to meet the needs of those who are not fluent in English.

Public authorities must ensure that systems are in place to ensure that information is available in such accessible formats in a timely fashion. In addition, specific consideration should be given to how to best communicate information to young people and those with learning disabilities.

Active Devon recommends that you should make special efforts to reach out to people whose
voices are seldom heard.

They also recommend giving consideration to the following questions when thinking about accessibility?

- Is the venue wheelchair accessible?
- Are there loop/signing/other facilities for people with a range of disabilities?

- Are the acoustics generally good?
- Is it clear that people can bring and use advocates?
- In complex buildings, is there a meeting and guiding service for those requiring it?
- Have arrangements been made and individuals trained to deal with emergency evacuations?
- Is the meeting in an area which will result in people of one community feeling uncomfortable about attending?
- Has access to and from the meeting also been considered?
- Will any audience that needs to be particularly targeted feel comfortable? For example, does the venue have a reputation for being 'gay unfriendly'?
- Will the arrangements for chairing and organising reflect this hospitality? For example, young people may come to a school to discuss youth problems but they may not find it easy to talk freely if teachers are running the session.
- Are the venues flexible enough to allow larger/smaller group discussions?
- Should the engagement be held during the day?
- Are the venues accessible by public transport, and if not can alternative transport arrangements be made? For example, for people with mobility impairments or for people with dependants and/or on low income.
- Are crèche facilities available?
- Are interpreters needed?

Evaluation

You will need to evaluate your engagement in terms of both process and content. The process evaluation will help you improve your engagement practice. The outcome evaluation will help you see the degree to which engaging with communities is actually having an impact on the project itself.

You need to think about how you're going to evaluate the process and outcomes from the very beginning of the pilot phase so that you can carry out successful evaluations all the way through.

Though different types of engagement will require different evaluation mechanisms here are some general things to think about.

- Were we able to involve 'hard to reach' groups?
- Did participants feel the engagement process enabled them to get their views across?
- Did people receive the information they needed to make a relevant response?
- Did enough people engage?
- Did we get good quality responses?

Process evaluation can generally be done by asking participants for their feedback on their experience of the process, either with follow-up materials like questionnaires or in follow-up interviews.

Evaluation will be based on your and participants' analysis as to whether or not people's feedback had an impact on the commissioning decisions. This evaluation is crucial in order to be able to report back to communities whether or not their feedback had an impact on the decisions that were made. (You may feel this not be important and local decisions can be made on this, the most important thing is that you get the best outcomes).

Evaluation Outcome:

- What information/knowledge emerged from the engagement that Local Delivery Partners had not previously been aware of?
- What impact did the feedback from communities have on the final programme design decisions?
- Would you describe this impact as substantial?

Summary

- When it comes to deciding how to engage with users, carers and communities you need to think about several of the decisions you made during the planning phase.
- What is your purpose?
- What objectives and outcomes do you want to achieve?
- Who are you?
- Who do you need to engage with?
- How can you use existing capacity, experience and partnerships?
- What are the practicalities of engagement?
- What might be the barriers to the engagement and how you plan to overcome those barriers?
- What level of engagement are you intending to work at?
- What is the overall commissioning decision-making process of which the engagement is part and to what degree will the feedback influence the final decision?
- How you intend to evaluate and monitor the success of the engagement, both in terms of process and content?
- How will you feed back the results of the engagement to the individuals/organisations?

One key piece of advice is to ask communities how *they* prefer to be engaged with.

Individuals and groups will have had positive and negative experiences of engagement and will have learnt a lot from the process. They probably have preferred methods. Working with them in partnership is the most effective way to come up with an effective method, which may mix and match some of the ideas below.

Local surveys/profiles
Focus groups
Community theatre
Neighbourhood forums

Community meetings
Telephone hotlines/local radio
Documentary
Stakeholder one-to-one's
Seminars/workshops
Consultative committees
User groups
Stakeholder conferences
Exhibitions

There are a huge number of engagement tools available to Local Delivery Partners; however, the key is that whatever method you choose has to be fit for purpose.
If people aren't engaging with you then you need to stop and think about why they aren't. Some reasons might be:

- Lack of time and resources;
- Didn't know the engagement process was happening;
- The venue wasn't accessible; and
- Disappointment with previous engagement processes turned them off

How might you persuade people to engage with you?

Recording feedback from the engagement sessions. Make sure that all comments are recorded during the engagement. Often it's helpful to bring along extra staff to make sure that there is someone or two people whose sole job it is to record feedback. You will need this information to inform your decision, but it's also a good idea to collate the feedback and send it to everyone who attended. This helps people work out whether or not their input was understood correctly and gives them the chance to make changes if something was taken down incorrectly.

Making decisions on the basis of engagement:

- How will you make sure that that information that was gathered as a result of engagement is shared with all members your organisation?
- Who will summarise and present the information?
- What standing will it be held in, especially in relation to other information? The communities that engage with you will have an expectation that their feedback will carry weight and you must be able to show how their feedback is incorporated into the decision-making process.

Monitoring and Evaluation

- Were we able to involve 'hard to reach' groups?
- Did participants feel the engagement process enabled them to get their views across?
- Did people receive the information they needed to make a relevant response?
- Did enough people engage?
- Did we get good quality responses?

How would you collect this information?

Monitoring forms at the end of sessions can give you information about where people are from both geographically and in terms of their community of interest or identity. But paper evaluations at the end of sessions aren't necessarily going to give you the deeper information about whether or not people felt they had enough information to be able to contribute meaningfully. In this case you will need to think about more detailed follow-up evaluation, perhaps with semi-structured interviews.

In addition, since literacy issues are an important element to think about when it comes to choosing engagement methods, they are crucial when it comes to evaluation. Do not assume that people will be able to fill out forms.

Outcome:

What information/knowledge emerged from the engagement that Local Delivery Partners had not previously been aware of?
What impact did the feedback from communities have on the final commissioning decision?
Would you describe this impact as minor, intermediate or substantial?

You need to look at the feedback you received and then at the final decision that was made. What impact did the feedback have on the decision? Was the impact substantial or minor?
What other variables had an impact on the final decision? Why was their impact more or less? The information needed will be there in the minutes of the decision-making. You will need to answer these questions and then be prepared to feed this back to the users, carers and communities you engaged with.

Maintain the relationship as part of the engagement cycle.

The engagement process is really a cycle. The engagement doesn't really have an exit strategy because you shouldn't want or need to exit from the engagement cycle, because before long you'll be back with the next year's plan, the new area of work or the new ministerial target and so looking for feedback from users, carers and communities. The key is to build and maintain relationships with communities that develop over time so that they can become partners with you.

If communities are co-planners with you, you will have a more rigorous, accurate and effective process.

One way to ensure an effective engagement process, rather than a series of less effective one-off engagements, is to maintain relationships. After each engagement session you have to return to the people you worked with to let them know the results of the engagement and what impact they had on the final decision. People understand that you face competing pressures on the final decisions and that sometimes other factors will weigh more heavily than their contribution. But people won't forgive you if you don't go back and tell them what impact their input had.

Give feedback.

Active Devon recommends that you ‘provide feedback to people about what you have learned from them and what action you intend to take in response. Demonstrate what change has occurred as a result of the engagement. Be held accountable.

Finally, give consideration to who delivers the programme of activities. The deliverer will be seen as the “front” of the programme, an ambassador and as such is in the prime position to collect vital feedback on programme design. This may inform further planned sessions or be as immediate as what to deliver in the next session.

Appendix C. Reasons for excluding studies from systematic review of community-level physical activity interventions

After examining the full articles, sixty-two studies were excluded from the review, for the reasons stated in the study inclusion criteria (Chapter 5.2.1). Three studies were excluded because they were not published in English (Reichenpfader et al., 2012; Tanaka et al., 2012; Vio et al., 2011). Nine studies were excluded because physical activity was not one of the primary outcomes (Cheadle et al., 2010; Garmendia et al., 2013; Gu, 2006; Guo et al., 2006; Hendricks et al., 2009; Mendonca et al., 2010; Pelssers et al., 2013; Van Acker et al., 2012; Ziebarth et al., 2012). Thirteen studies were excluded because they did not use a population sample, but rather participants versus non-participants (Duru et al., 2010; Fisher & Lee, 2004; Fitzpatrick et al., 2008; Folta et al., 2009; Haruyama et al., 2009; Hillier et al., 2012; Kimura et al., 2013; Lombard et al., 2010; Marshall et al., 2004; Pasalich et al., 2013; Van Hoecke et al., 2012; Wilcox et al., 2009; Yan et al., 2009). Six studies were excluded because they focused on a very specific community, rather than the wider population (Baker et al., 2010; Dirige et al., 2013; Hayashi et al., 2010; Kontogianni et al., 2012; Lombard et al., 2009; Morgan et al., 2010). Five studies were excluded because they did not examine community-level interventions, but rather studies that involved randomised households or individuals (French et al., 2011; Greaney et al., 2008; Richardson et al., 2010; Tudor-Smith et al., 1998; Wellman et al., 2007). Four studies were excluded because they incorporated a clinical or healthcare setting (Chao et al., 2012; Hardcastle et al., 2012; Martinson et al., 2008; Parra-Medina et al., 2011). Nine studies were excluded because they did not include control communities (Ayala et al., 2011; Bauman et al., 2003; Farag

et al., 2010; Hersey et al., 2012; Jiang et al., 2013; McCracken et al., 2013; Van Acker et al., 2011; Wen et al., 2002; Wilcox et al., 2008). Six studies were excluded because they focused on communities that were not from developed countries (Kelishadi et al., 2009; Nguyen et al., 2012; Pazoki et al., 2007; Rabiei et al., 2010; Sadeghi et al., 2011; Simoes et al., 2009). Finally, seven studies were excluded for other reasons, for example protocol papers or environmental design interventions (From et al., 2013; Sayers et al., 2012; Chomitz et al., 2012; Kegler et al., 2012; Croker et al., 2012; Sharpe et al., 2010; Suminski et al., 2009).

Appendix D. Abstraction form for systematic review of community-level physical activity interventions

PAPER NUMBER	
CITATION	
INTERVENTION TITLE	
STUDY DESIGN	
TYPE OF INTERVENTION (COMPONENTS)	
TARGET OF INTERVENTION	
THEORY DESCRIBED	
COMMUNITY TYPE	
LOCATION	
RURAL/URBAN	
COMPARISON COMMUNITIES	
PRIMARY OUTCOME MEASURES	
SECONDARY OUTCOME MEASURES (IF RELEVANT)	
HOW OUTCOMES	

WERE MEASURED	
RESULTS: AGE	
NUMBER OF PARTICIPANTS	
GENDER	
RACE/ETHNICITY	
SOCIOECONOMIC STATUS	
OUTCOMES	
SAMPLE SIZE SUFFICIENT?	
FEASIBILITY & OTHER KEY ISSUES ADDRESSED IN PAPER	

Appendix E. Reasons for excluding studies from systematic review of physical activity correlates

After examining the full articles, seventy-two studies were excluded from the review, for the reasons stated in the study inclusion criteria (Chapter 6.2.1). Twenty-five studies were excluded because they focused on a population that was too specific (Ainsworth et al., 2003; Bungum et al., 2011; 2012; Burton et al., 1999; Carter-Parker et al., 2012; Caudroit et al., 2011; Haley & Andel, 2010; James et al., 2003; McTiernan et al., 1998; Mier et al., 2007; Mullie et al., 2013; Nishida et al., 2003; Perez et al., 2011; Rohm Young & Voorhees, 2003; Romaguera et al., 2011; Sanderson et al., 2003; Schmitz et al., 1997; Steindorf et al., 2010; Steptoe et al., 1997; Stutts, 2002; Voorhees & Rohm Young, 2003; Wilbur et al., 2003; Wilcox et al., 2003; Zizzi et al., 2006; Zou et al., 2012). Twenty-two studies were excluded because they were not set in developed countries (Ammouri et al., 2007; Biernat & Tomaszewski, 2011; Chen et al., 2011; Del Duca et al., 2013; Gomez et al., 2004; Jaime et al., 2011; Jurj et al., 2007; Katulanda et al., 2012; 2013; Lee et al., 2007; Lobaszewski et al., 2011; Momenan et al., 2011; Najdi et al., 2011; Ogwumike et al., 2012; Oka & Shibata, 2012; Oyeyemi et al., 2011; Parra et al., 2011; Saito et al., 2013; Shibata et al., 2009; Sigmundova et al., 2011; Suzuki et al., 2011; Vagetti et al., 2013;). Eleven studies were excluded because they were review articles rather than experimental articles (Bauman et al., 2012; Eyler, 2003; Eyler et al., 2002; Kirk & Rhodes, 2011; Koeneman et al., 2011; Olsen, 2013; Plonczynski, 2003; Rhodes & Smith, 2006; Sherwood & Jeffery, 2000; Trost et al., 2002; Wendel-Vos et al., 2007). Eight studies were excluded because they focused on a specific correlate of physical activity, rather than a range of physical activity

correlates (Blanchard et al., 2005; De Bourdeauhuij et al., 2003; Gallagher et al., 2012; Garcia Bengoechea et al., 2005; Hoerster et al., 2011; Kamada et al., 2009; King et al., 2006; Owen et al., 2000). Three studies were excluded because they focused on physical activity correlates for cancer prevention, rather than correlates for general health (Aparicio et al., 2013; Ishii et al., 2011; 2013). Two studies were excluded because they were not published in English (La Torre et al., 2006; Rodriguez-Romo et al., 2011). One study was excluded because it only reported the study protocol (McNaughton et al., 2012).

Appendix F. Abstraction form for systematic review of physical activity correlates

PAPER NUMBER	
CITATION	
STUDY DESIGN	
THEORY	
COUNTRY/ LOCATION	
AGE OF SAMPLE	
MALE/FEMALE/ BOTH	
RACE/ ETHNICITY	
SOCIO-ECONOMIC STATUS	
RURAL/URBAN	
COMMUNITY TYPE	
PA OUTCOME MEASURES	
HOW OUTCOMES WERE MEASURED	

NO. OF PARTICIPANTS	
CORRELATES MEASURED	
OUTCOMES	
SAMPLE SIZE SUFFICIENT?	
STRENGTHS & LIMITATIONS & BIASES	

Appendix G. DAVE study protocol paper

Citation:

Solomon E, Rees T, Ukoumunne OC, Hillsdon M: **The *Devon Active Villages Evaluation* (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England.** *BMC Public Health* 2012, **12:**581.

Title

The *Devon Active Villages Evaluation* (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England

Authors

Emma Solomon[1] (es244@exeter.ac.uk)

Tim Rees[1] (tim.j.rees@exeter.ac.uk)

Obioha C Ukoumunne[2] (obioha.ukoumunne@pcmd.ac.uk)

Melvyn Hillsdon[1] (M.Hillsdon@exeter.ac.uk)

Affiliations

[1]Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter, St. Lukes Campus, Heavitree Road, Exeter, EX1 2LU, United Kingdom.

[2]PenCLAHRC, Peninsula College of Medicine and Dentistry, University of Exeter, Veysey Building, Salmon Pool Lane, Exeter, United Kingdom.

Corresponding Author

Emma Solomon

Abstract

Background

Although physical inactivity has been linked with numerous chronic health conditions and overall mortality, the majority of English adults report doing insufficient physical activity. To increase population physical activity levels, researchers have called for more community-level interventions. To evaluate these complex public health interventions, innovative study designs are required. This study protocol describes *Devon Active Villages*, a community-level intervention providing physical activity opportunities to 128 rural villages in southwest England, and the methods used to evaluate its effectiveness in increasing physical activity levels.

Methods/Design

A stepped wedge cluster randomised trial will be used to evaluate whether *Devon Active Villages* leads to increased physical activity levels in rural communities. Community engagement will help tailor activity programmes for each village; communities will then be supported for a further twelve months. The intervention will be delivered over four periods, each lasting twelve weeks. Data collection consists of a postal survey of a random sample of adults aged 18 years and over, at baseline and after each of the four intervention periods. The questionnaire includes questions on participant demographics, physical activity behaviour, local environment characteristics, awareness of local activity programmes, and psychosocial factors. Based on detecting an increase in the proportion of people who meet physical activity guidelines (from 25% to 30%),

at least ten respondents are needed from each of the 128 villages at each stage (80% power at the 5% level of significance). Anticipating a 20% response rate, 6,400 questionnaires will be sent out at each stage (i.e., 50 surveys to each village). Using data from all five periods, a comparison of study outcomes between intervention and control arms will be performed, allowing for time period (as a fixed effect) and the random effect induced by correlation of outcomes (clustering) within villages.

Discussion

This paper describes the use of a stepped wedge cluster randomised trial to evaluate a complex, community-level physical activity intervention in an under-studied population of adults in rural communities in southwest England. The study addresses gaps in the current literature by providing new insights into physical activity levels in this population.

Keywords

Physical activity, stepped wedge cluster randomised trial, community-level intervention, rural communities.

Background

In developed and many developing countries physical inactivity is one of the most important public health problems of the 21st century (World Health Organization, 2009). There is strong evidence linking physical inactivity with various chronic conditions, such as coronary heart disease, stroke, type 2 diabetes, cancer, obesity and mental health problems (World Health Organization, 2009; Department of Health, Physical Activity, Health Improvement and Protection, 2011; Physical Activity Guidelines Advisory Committee, 2008), and physical inactivity has been identified as a leading risk factor for mortality, estimated to cause 6% of deaths globally (World Health Organization, 2010). In contrast, the numerous benefits of a physically active lifestyle have been well documented (Physical Activity Guidelines Advisory Committee, 2008). Despite the preceding evidence, in England only 29% of women and 39% of men report doing sufficient physical activity to meet the minimum recommended guidelines of 150 minutes of moderate intensity physical activity per week or 75 minutes of vigorous intensity physical activity per week (Craig et al., 2009). This level of physical inactivity is estimated to cost the United Kingdom National Health Service £0.9 billion per year (Scarborough et al., 2011).

Substantial health benefits can be achieved through relatively modest changes in activity behaviour among large segments of the population (Haskell et al., 2007), and therefore physical activity interventions are now considered to be as important to population health as other high profile interventions, such as those lowering tobacco use or reducing blood pressure (Department of Health, Physical Activity, Health Improvement and Protection, 2011). Although the health benefits of physical activity are now well-established, little is known about

the effectiveness of interventions designed to improve population physical activity (Foster et al., 2005). The majority of physical activity interventions have been delivered at the level of the individual, aimed at changing personal behaviour (House of Lords: Science and Technology Select Committee, 2011). To change population prevalence, interventions need to be effective, but they also need to reach large numbers of people. Although some individual-level interventions are effective, their reach is limited when compared with community-level interventions. It is community-level interventions that have the potential to produce long-lasting benefits for the whole community, but evidence as to which type of community-wide interventions are most effective is currently weak (Baker et al., 2011).

A recent review of research examining the effectiveness of community-level interventions to promote physical activity reported that many studies used weak evaluation designs, such as uncontrolled, pre-post evaluations, and could not attribute any observed changes to the intervention (Baker et al., 2011). One example of a community-level intervention evaluation that did include control communities—but was non-randomised—was the 'Cycling Demonstration Towns' programme in England (Sloman et al., 2009), in which the intervention involved town-wide media campaigns, personalised travel planning, cycle training, repair services, and cycling infrastructure improvements. A controlled, repeated cross-sectional study examined the effect of the intervention in six towns between 2005 and 2008 using telephone surveys of quota samples of local residents (Sloman et al., 2009). The average annual percentage increase in the number of cyclists on the road was 4%. Net increases were also found in the proportions of residents who reported cycling for at least 30 minutes on 12

or more days per month (0.97% or 1.65%, depending on the choice of control areas; Sloman et al., 2009).

Reviews of physical activity correlates suggest that a combination of personal, social and environmental factors are associated with physical activity prevalence (Trost et al., 2002), but there are very few evaluations of the effects of changes to either social or built environments, and studies of the built environment are almost exclusively restricted to urban environments (Baker et al., 2011; Ogilvie et al., 2010). Both urban and rural dwellings report similarly low levels of physical activity in adults: on average, 9.5 days per month (95% CI: 9.3-9.6) of moderate-to-vigorous intensity physical activity for at least 30 minutes (Craig et al., 2009). Although 20% of the population live in non-urban dwellings (Craig et al., 2009), rural populations are generally understudied (Ogilvie et al., 2010; Saelens et al., 2002). Additionally, access to recreational facilities and other environmental supports for physical activity (e.g., neighbourhood 'walkability', convenient access to destinations, and perceived safety) have been shown to be related to physical activity participation (Bauman & Bull, 2007), with people in rural areas being more likely to report lack of facilities as a barrier to physical activity (Brownson et al., 2000).

Randomised controlled trials are considered the most powerful tool in research design for evaluating interventions, due to their rigorous study design and strict randomisation procedures (Sibbald & Roland, 1998). Traditional randomised controlled trials, where individual participants are randomised, are not always reproducible in the real world and tend to focus on individuals rather than communities, raising doubts about whether a subsequent scaling up of individual interventions to larger populations would lead to changes in population prevalence (Sanson-Fisher et al., 2007). It has been suggested that

when evaluating interventions that are by necessity delivered to groups rather than individuals, cluster randomised trials, which randomise groups (e.g., communities, villages, towns) and measure outcomes on individual participants within those groups, are more appropriate (House of Lords: Science and Technology Select Committee, 2011; Craig et al., 2008).

Cluster randomised trials commonly use a parallel group design, in which the clusters are randomised to either the intervention or control arm of the study. For practical reasons it is often not possible to deliver an intervention to many clusters at the same time. In addition, it is often regarded as unethical to withhold an intervention from a proportion of participants if it is believed that the intervention will do more good than harm. In these circumstances, stepped wedge trial designs (Cook & Campbell, 1979), where the intervention is delivered sequentially to all trial clusters over a number of time periods, is an alternative to the traditional parallel groups design. In a stepped wedge design, clusters effectively cross over from the control to the intervention group. The stage at which the clusters cross over is randomised. Outcomes are measured on the study participants in all clusters at every time period so that each cluster provides data points in both the control and intervention conditions (Brown & Lilford, 2006). Examples of stepped wedge investigations include the efficacy of Hepatitis B vaccinations (Gambia Hepatitis Study Group, 1987), the effect of housing improvements on respiratory health symptoms (Somerville et al., 2002), and different tuberculosis treatments on number of disease episodes (Grant et al., 2005).

The objective of this paper is to describe the protocol of a stepped wedge cluster randomised trial for evaluating the effectiveness of a community-level intervention to increase physical activity in rural villages in southwest

England. The intervention will identify community needs and then provide resources and support to initiate local activity programmes, ultimately aiming for the activities to become self-sustaining over time. The intervention is expected to improve physical activity participation after each village receives the intervention. It is also anticipated that changes will be observed in levels of social support, physical activity intentions, awareness and use of local facilities, and perceived village supportiveness of physical activity.

Methods/Design

Study design

The *Devon Active Villages Evaluation* (DAVE) protocol is based on a stepped wedge cluster randomised controlled trial design (Figure 1). During the DAVE study, the intervention will be rolled out sequentially to 128 rural villages (clusters) over four time periods. The evaluation will consist of data collection at five fixed time points (baseline and following each of the four intervention periods). The period in which the villages first receive the intervention will be randomly assigned, stratified by the seven regions of the county of Devon (see below). The intervention will be fully implemented by the end of the trial, with all 128 villages receiving the intervention: 22 first receiving the intervention at period 2, 36 at period 3, 35 at period 4, and 35 at period 5.

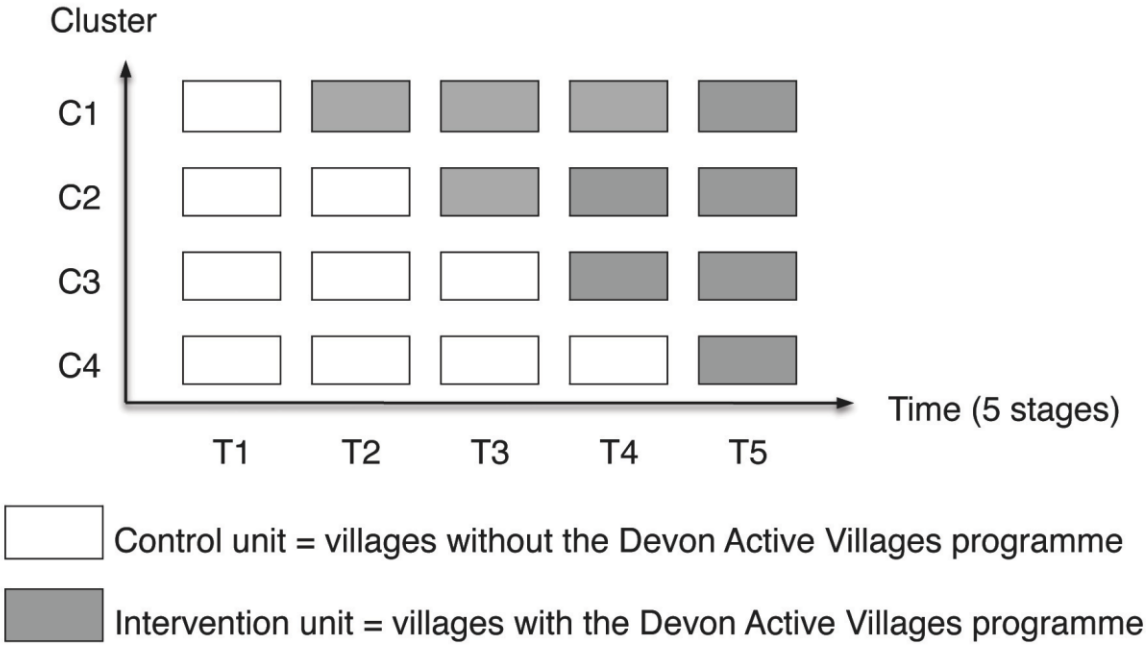


Figure 1: Design of the DAVE study
One cluster (C1, C2, C3 or C4) represents one group of intervention villages. Each time period (T1, T2, T3, T4, or T5) represents a data collection point. Each unit (control or intervention) represents one time period of one cluster.

Setting and participants

Devon Active Villages is a community-level intervention coordinated by *Active Devon,* the Devon county partnership for sport and physical activity. Active Devon received circa £950,000 funding for the Devon Active Villages intervention from Sport England (the government body for sports promotion) and Devon County Council as part of Sport England's 'Rural Communities' funding scheme. The Devon Active Villages Evaluation (DAVE) research study is being conducted by the University of Exeter in close liaison with Active Devon.

Devon is characterised by ten distinct regions, of which three are urban (Exeter, Plymouth and Torbay), and seven are rural (East Devon, Mid Devon, North Devon, South Hams, Teignbridge, Torridge and West Devon). All intervention villages are located in one of the seven rural regions. The Devon Active Villages intervention will provide activities for all age groups.

In the initial planning of the intervention, Active Devon identified 155 rural villages to receive the Devon Active Villages intervention across the course of three years. Prior to the intervention, Active Devon ran a pilot intervention with 15 villages, the outcome of which was used to inform the main intervention protocol.

Recruitment and randomisation

Of the remaining 140 villages that were not part of the pilot, twelve could not be included in the evaluation due to engagement with local community members before baseline data collection had commenced. Thus, the remaining 128 villages (clusters) were recruited and randomised to first receive the intervention in one of the four periods, stratified by region. Villages with populations of 500-2000 people formed the sampling frame for the intervention. These population boundaries were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities they offered.

Data collection for the evaluation study will focus on adults aged 18 years and over. The study will use a repeated cross-sectional design, in which a random sample of people within each cluster will be surveyed at each stage. A complete list of all households in each of the 128 study villages will be obtained using the Postcode Address File (Address List Utility, Arc en Ciel, Version 3.1 PAF Quarter 1, 2011). The order in which households are approached to participate in the survey at each stage will be randomly generated. One adult per household will be randomly selected. If there are multiple eligible adults in the household, an invitation to complete the survey will be given to the adult who has most recently had a birthday.

Intervention

The primary objective of the Devon Active Villages intervention is to improve participation in physical activity by offering people of all ages increased opportunities to experience the enjoyment of sport and physical activity. The intervention will be implemented and coordinated locally by Local Delivery Partners. Local Delivery Partners include District Authority Sports Development Teams and community-based charitable organisations, some of which manage local facilities as well as maintain and develop activity opportunities in the local area. Each Local Delivery Partner will deliver the intervention in one of the seven regions. It was necessary to have different Local Delivery Partners for each area due to the large number of villages receiving the intervention in each period, and because the villages are spread across the whole county. No one Local Delivery Partner is of sufficient size to cover the whole county. Each Local Delivery Partner is given strategic support from Active Devon as well as a clear framework and timescales around the delivery of the intervention with strong focus on generating a local needs led approach to designing the activities.

Each village will receive a ‘community engagement phase’ for twelve weeks prior to the intervention (Figure 2). During this phase, Local Delivery Partners will engage with the local people, elected member structures, schools and other community groups to carry out a local needs assessment, an assessment of the activities currently on offer, and the activities’ take-up and capacity. This will often include, but not limited to, people being directly surveyed to find out what activities they would like the Devon Active Villages programme to provide.

The programme will then deliver twelve weeks of physical activity sessions, with each village receiving at least three different types of activities. These activity sessions will be subsidised using programme funds. Local Delivery Partners will coordinate delivery of the intervention by finding suitable activity venues, purchasing necessary equipment and hiring local experts to deliver the activities. Community volunteers will also be recruited to help run the activities and will be provided with mentoring support throughout the programme. Local Delivery Partners will advertise the Devon Active Villages activity sessions using local media (e.g., newspapers, posters, leaflets, village newsletters).

Each village will also be supported for twelve months following the intervention, when Local Delivery Partners will help the communities to sustain the intervention activities, by providing specialist support, regular mentoring for the volunteers and additional funding or equipment if necessary. Additionally, local people will be offered coaching qualifications to help the villages continue the activities independently.

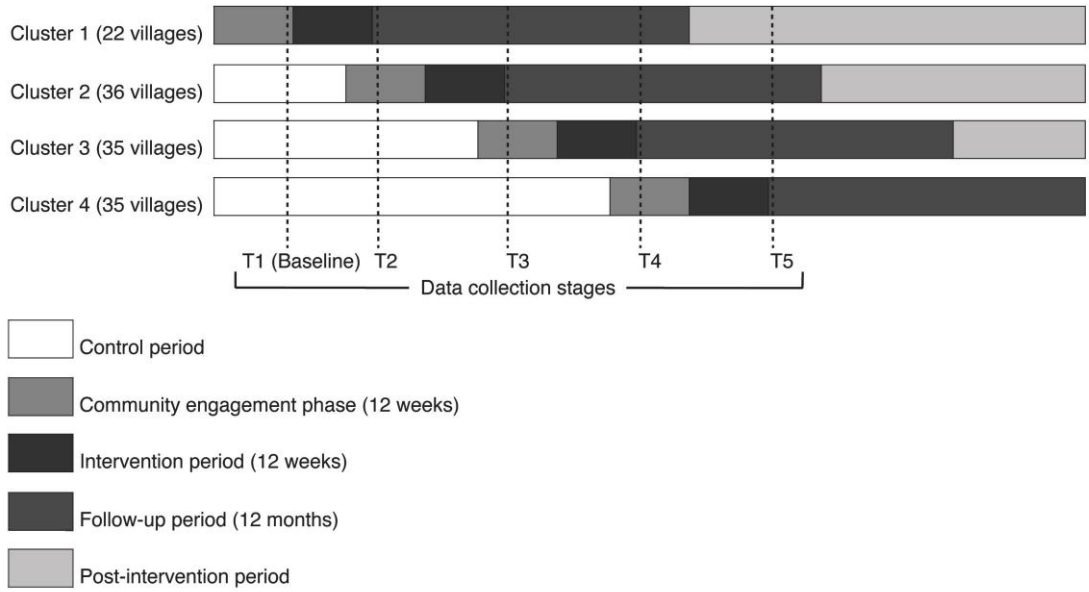


Figure 2: Data collection timeline for the Devon Active Villages Evaluation study

Outcome measurement

The primary analysis will compare the proportion of adults meeting recommended guidelines for the minimum level of physical activity (i.e., 150 minutes of moderate intensity physical activity per week or 75 minutes of vigorous intensity physical activity per week) between the intervention and control modes. Secondary outcomes will be social support, physical activity intentions, awareness and use of local facilities, perceived village supportiveness of physical activity, and awareness and participation in the Devon Active Villages intervention.

Data collection

Postal questionnaires will be sent out to participants at baseline (in the month prior to the first intervention period commencing) and within a week of each of the four intervention periods ending (figure 2). If the number of completed questionnaires returned within three weeks of the initial mailing is insufficient, additional questionnaires will be sent out to new households. Participants will receive the questionnaire, an information letter and a prepaid return envelope. It is possible that some individuals may receive the questionnaire on two or more occasions. In such cases, if returned, demographic variables (gender, age, height, weight) will be used to identify this wherever possible. These participants will remain in the analysis, but it will be recorded that each participant has completed the questionnaire on more than one occasion.

Measures

Demographic characteristics

The survey will include questions on gender, age, height, weight, health, occupation, car ownership, children in the household, and dog ownership, based on questions from national surveys from different populations (e.g., Burton et al., 2007; Craig et al., 2009).

Physical activity

Physical activity will be measured using the short version of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The IPAQ short-form consists of questions on the number of days and time spent on physical activity at moderate and vigorous intensity, as well as time spent walking and sitting. The mean values for each activity category will be calculated and expressed as metabolic equivalent (MET) minutes per week, and combined to categorise people into ‘low’, ‘moderate’ or ‘high’ activity classifications. The self-administered short-form IPAQ has been found to have acceptable levels of validity and reliability (Craig et al., 2003).

Local area

To assess perceived characteristics of the local environment a scale will be used that was initially developed for use in another United Kingdom health study. Participants are asked to rate their agreement with 12 items on factors such as aesthetics, green space, access to amenities, traffic, safety and convenience of routes. The scale has been found to have acceptable levels of test-retest reliability (Ogilvie et al., 2008). Questions on perceived proximity and use of different recreational facilities are also included. These items were previously found to have acceptable test-retest reliability (Sallis et al., 1997).

Physical activity campaigns/programmes

The survey will contain questions on participants’ awareness of and participation in local physical activity campaigns. The survey will also ask about

awareness of Devon Active Villages, participation in programme events, and opinions on the programme.

Psychosocial correlates

Participants will be asked about their intentions to be more active in the future. The survey will also ask them to rate the importance they place on physical activity on a scale from 0 (not at all) to 10 (very), as well as their physical activity confidence and the extent to which they are trying to do more activity (Miller & Johnson, 2008). Finally, a series of eight questions will ask participants to rate their agreement with statements about their physical activity habits, social norms, and perceived village supportiveness of activity. These questions were initially developed for use in an Australian cohort study (n=2,485; Burton et al., 2007).

Sample size

To detect an increase from 25% to 30% in the percentage of people who meet guidelines for recommended physical activity levels, 10 participants need to be recruited from each of the 128 villages at each study period to achieve 80% power at the 5% significance level (Hussey & Hughes, 2007). A recent pilot for a population study of travel behaviour in the United Kingdom achieved a response rate of 20% for a short questionnaire postal survey (Sahlqvist et al., 2011). On this basis, 50 surveys will be sent out to each village at each stage, anticipating that we will obtain at least 10 responses per village per stage (20% response rate). This means that 6,400 surveys will be sent out at every stage with the expectation that at least 1,280 will be completed and returned. If this response rate is not achieved within three weeks of the surveys being posted,

an additional five surveys will be sent out to extra households for every one survey missing (20% response rate).

Statistical analysis

For any given outcome, data collected across all five periods will be used in a single analysis comparing the intervention and control modes. Analyses will use the intention-to-treat principle, with participants analysed according to the mode their village (cluster) was in for the stage at which they provided outcome data. Random effects ("multilevel") linear regression models estimated using maximum likelihood (Schall, 1991) will be fitted to compare quantitative outcomes between the intervention and control modes, specifying the village effect as random; marginal logistic regression models using Generalised Estimating Equations (GEE) with information sandwich ("robust") estimates of standard error specifying an exchangeable correlation structure (Hanley et al., 2003) will be fitted to compare binary outcomes. Both the random effects model and GEE methods allow for correlation of outcomes within the same village cluster. Under both methods, a binary predictor variable will be used to indicate intervention versus control status and period of study, gender and age will be adjusted for. All analyses will be carried out using Stata software (StataCorp. 2011. *Stata Statistical Software: Release 12.* College Station, TX: StataCorp LP).

Ethical consideration

The study received ethical approval from the Sport and Health Sciences Ethics Committee at the University of Exeter (February 2011).

Discussion

This paper has outlined the Devon Active Villages Evaluation study design and data collection, as well as details on the implementation of the intervention. The DAVE study is the first to use a stepped wedge cluster randomised controlled trial design to evaluate the effectiveness of a community-level intervention designed to increase physical activity. The stepped wedge design is advantageous in studies where the intervention cannot be withheld from a proportion of the population and cannot be delivered to all intervention clusters at the same time. This study will demonstrate that it is possible to evaluate physical activity interventions using a stepped wedge trial design.

Strengths of the study will include the number of participating villages and the multiple data collection stages. The main limitation of the study is the self-reported outcome measure of physical activity that may lead to some misclassification. The implementation of the Devon Active Villages intervention may increase physical activity participation in rural villages in southwest England. The results from the study will contribute to the limited research available on physical activity in rural communities in England and other developed countries. This pragmatic evaluation of a community-led intervention is expected to provide a model of how to evaluate physical activity promotion in the community when it is being delivered by local organisations that frequently deliver such interventions with no evaluation at all. The study should help demonstrate how independent researchers and practitioners can successfully work together to evaluate natural experiments in real life settings.

In conclusion, the Devon Active Villages Evaluation study is believed to fill gaps in the current literature, providing new insights into rural physical activity, using innovative study designs to evaluate the intervention, and

developing collaborations between researchers and practitioners to evaluate natural experiments. Therefore, the results from this study will contribute to the body of evidence on stepped wedge cluster randomised trials and community-level interventions, and may be useful for researchers and practitioners for future evaluations of complex public health interventions. In addition, if the Devon Active Villages intervention proves successful in improving population physical activity prevalence the intervention could be disseminated at national and international level.

Competing interests

As part of an Economic and Social Research Council PhD CASE Studentship grant, the research is partially funded by Active Devon, but the research work and results are completely independent and not biased by the opinions of Active Devon.

Authors' contributions

The study chief investigators ES, TR and MH were responsible for identifying the research question, the design of the study, obtaining ethics approval and the acquisition of funding. OCU contributed to the fine-tuning of the methodology and statistical analysis. All authors helped draft and revise the manuscript and approved the final version.

Acknowledgements and Funding

We thank Active Devon for their support of the research project. This research was supported by the Economic and Social Research Council under its Capacity Building Clusters Award (RES-187-24-0002). The research was

also funded by the National Institute for Health Research (NIHR) Collaborations for Leadership in Applied Health Research and Care (CLAHRC). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health.

References

Baker PRA, Francis DP, Soares J, Weightman AL, Foster C: **Community wide interventions for increasing physical activity.** *Cochrane Db Syst Rev 2011* 2011, Issue 4.

Bauman A, Bull F: *Environmental Correlates of Physical Activity and Walking in Adults and Children: A Review of Reviews.* Loughborough: National Institute of Health and Clinical Excellence (NICE); 2007.

Brown CA, Lilford RJ: **The stepped wedge trial design: a systematic review.** *BMC Med Res Methodol* 2006, **6:**54.

Brownson RC, Housemann RA, Brown DR, Jackson-Thompson J, King AC, Malone BR, Sallis JF: **Promoting physical activity in rural communities: Walking trail access, use, and effects.** *Am J Prev Med* 2000, **18:**235-241.

Burton NW, Oldenburg B, Sallis JF, Turrell G: **Measuring psychological, social, and environmental influences on leisure-time physical activity among adults.** *Aust N Z J Public Health* 2007, **31:**36-43.

Cook TD, Campbell D: *Quasi-experimentation: Design and analysis issues for field settings.* Boston: Houghton Mifflin; 1979.

Craig P, Dieppe P, Macintyre SJ, Michie S, Nazareth I, Petticrew M: *Developing and evaluating complex interventions: new guidance.* Medical Research Council; 2008.

Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P: **International physical activity questionnaire: 12-country reliability and validity.** *Med Sci Sport Exer* 2003, **35:**1381-1395.

Craig R, Mindell J, Hirani V (Eds): *Health Survey for England 2008, Volume 1: Physical activity and fitness.* Leeds: The NHS Information Centre; 2009.

Department of Health, Physical Activity, Health Improvement and Protection: *Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers.* London: Department of Health; 2011.

Foster C, Hillsdon M, Thorogood M: **Interventions for promoting physical activity (Review).** *Cochrane Db Syst Rev 2005* 2005, Issue 1.

Gambia Hepatitis Study Group: **The Gambia Hepatitis Intervention Study.** *Cancer Res* 1987, **47:**5782-5787.

Grant AD, Charalambous S, Fielding KL, Day JH, Corbett EL, Chaisson RE, De Cock KM, Hayes RJ, Churchyard GJ: **Effect of routine Isoniazid preventative therapy on Tuberculosis incidence among HIV-infected men in South Africa.** *J Amer Med Assoc* 2005, **22:**2719-2725.

Hanley JA, Negassa A, Edwardes MDd, Forrester JE: **Statistical Analysis of Correlated Data Using Generalized Estimating Equations: An Orientation.** *Am Journal Epidemiol* 2003, **157:**364-375.

Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A: **Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association.** *Circulation* 2007, **116:**1081-1093.

House of Lords: Science and Technology Select Committee: *Behaviour Change.* London: Authority of the House of Lords; 2011.

Hussey MA, Hughes JP: **Design and analysis of stepped wedge cluster randomized trials.** *Contemp Clin Trials* 2007, **28:**182-191.

Miller WR, Johnson WR: **A natural language screening measure for motivation to change.** *Addict Behav* 2008, **33:**1177-1182.

Ogilvie D, Griffin SJ, Jones A, Mackett R, Guell C, Panter J, Jones N, Cohn S, Yang L, Chapman C: **Commuting and health in Cambridge: a study of a 'natural experiment' in the provision of new transport infrastructure.** *BMC Public Health* 2010, **10**:703.

Ogilvie D, Mitchell R, Mutrie N, Petticrew M, Platt S: **Perceived characteristics of the environment associated with active travel: development and testing of a new scale.** *Int J Behav Nutr Phy* 2008, **5:**32.

Physical Activity Guidelines Advisory Committee: *Physical Activity Guidelines Advisory Committee Report.* Washington, DC: U.S. Department of Health and Human Services; 2008.

Saelens BE, Sallis JF, Frank LD: **Environmental correlates of walking and cycling: findings from the transportation, urban design and planning literatures.** *Ann Behav Med* 2002, **25:**80-91.

Sahlqvist S, Song Y, Bull F, Adams E, Preston J, Ogilvie D: **Effect of questionnaire length, personalisation and reminder type on response rate to a complex postal survey: randomised controlled trial.** *BMC Med Res Methodol* 2011, **11**.

Sallis JF, Johnson MF, Calfas KJ, Caparosa S, Nichols JF: **Assessing perceived physical environmental variables that may influence physical**

activity. *Res Q Exercise Sport* 1997, **68:**345-351.

Sanson-Fisher RW, Bonevski B, Green LW, D'Este C: **Limitations of the Randomized Controlled Trial in Evaluating Population-Based Health Interventions.** *Am J Prev Med* 2007, **33:**155-161.

Scarborough P, Bhatnagar P, Wickramasinghe KK, Allender S, Foster C, Rayner M: **The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 NHS costs.** *J Public Health* 2011, **May**.

Schall R: **Estimation in Generalized Linear Models with Random Effects.** *Biometrika* 1991, **78:**719-727.

Sibbald B, Roland M: **Understanding controlled trials: Why are randomised controlled trials important?** *Brit Med J* 1998, **316**: 201.

Sloman L, Cavill N, Cope A, Muller L, Kennedy A: *Analysis and synthesis of evidence on the effects of investment in six Cycling Demonstration Towns.* Department for Transport and Cycling England; 2009.

Somerville M, Basham M, Foy C, Ballinger G, Gay T, Shute P, Barton AG: **From local concern to randomised trial: the Watcombe Housing Project.** *Health Expectations* 2002, **5:**127-135.

Trost SG, Owen N, Bauman AE, Sallis JF, Brown W: **Correlates of adults' participation in physical activity: review and update.** *Med Sci Sports Exerc* 2002, **34:**1996-2001.

World Health Organization: *Global Health Risks: Mortality and burden of disease attributable to selected major risks.* Geneva, Switzerland: World Health Organization; 2009.

World Health Organization: *Global Recommendations on Physical Activity for Health.* Geneva, Switzerland: World Health Organization; 2010.

Appendix H. Ethical approval certificate

UNIVERSITY OF EXETER

SPORT AND HEALTH SCIENCES

College of Life and Environmental Sciences
St Luke's Campus
Heavitree Road
Exeter UK EX1 2LU

t +44 (0) 1392 722807
f +44 (0) 1392 724726
e sshs-school-office@exeter.ac.uk
w sshs.exeter.ac.uk

Certificate of Ethical Approval

Proposal A2 (04/05/11)
Title: Understanding the impact upon physical activity of "Devon Active Villages"
Applicants: Dr Tim Rees with Dr Melvyn Hillsdon and Dr O Ukoumunne and Emma Solomon (PGR Student)

The proposal was reviewed by a Representative on the Committee.

Decision: The proposal was approved from February 2011 to March 2013

Signature: D.Wilkerson Date: 05/04/12

Name/Title of Ethics Committee Reviewer: Dr. D. Wilkerson

Your attention is drawn to the attached paper which reminds the researcher of information that needs to be observed when Ethics Committee approval is given.

Appendix I. Survey

Rural Devon Activities Survey

Section 1: Your local area

This section asks for your views about your **local area.** Think of your local area as everywhere within a ten-minute walk (about half a mile) from your home.

Q1. How long have you lived in your local area?
If you have lived in this area previously and come back again, please just answer about the current period of time that you have lived in your local area:

Write in [ ] years *and* [ ] months

Q2. How would you describe your local area now? For each of these statements please circle how much you agree or disagree:
(please circle one number on each line)

In my local area….	STRONGLY AGREE	TEND TO AGREE	NEITHER AGREE NOR DISAGREE	TEND TO DISAGREE	STRONGLY DISGAREE	DON'T KNOW
It is pleasant to walk	1	2	3	4	5	6
There is a lot of traffic noise	1	2	3	4	5	6
There is a park within walking distance	1	2	3	4	5	6
The roads are dangerous for cyclists	1	2	3	4	5	6
There is convenient public transport	1	2	3	4	5	6
There are convenient routes for cycling	1	2	3	4	5	6
It is safe to walk after dark	1	2	3	4	5	6
The nearest shops are too far to walk to	1	2	3	4	5	6
There is little traffic	1	2	3	4	5	6
There are no convenient routes for walking	1	2	3	4	5	6
It is safe to cross the road	1	2	3	4	5	6
There are no pavements	1	2	3	4	5	6

Q3. Which of these things are within walking distance or a short drive (within 3 miles) from where you live? *(please circle one number on each line)*

	YES	NO	DON'T KNOW
Walking routes/footpaths	1	2	3
Local park/public green space	1	2	3
Sporting club/recreation centre/gym	1	2	3
River/beach/waterfront	1	2	3
Public swimming pool	1	2	3
Public tennis/squash courts	1	2	3
Indoor sports facilities (e.g., sports hall)	1	2	3
Community centre/village hall (where exercise classes are held)	1	2	3

Q4. Have you ever used any of the following recreational facilities?
If yes, please circle the number showing how recently, **AND** give the name of the village/town/city the facility is in. If no, please circle the number under **'NO'**.

	YES, IN THE LAST MONTH	YES, IN THE LAST 12 MONTHS	NO, NOT IN THE LAST YEAR	NAME VILLAGE/ TOWN/CITY
Walking routes/footpaths	1	2	3	
Local park/public green space	1	2	3	
Sporting club/recreation centre/gym	1	2	3	
River/beach/waterfront	1	2	3	
Public swimming pool	1	2	3	
Public tennis/squash courts	1	2	3	
Indoor sports facility (e.g., sports hall)	1	2	3	
Community centre/village hall	1	2	3	

Section 2: Awareness of local programmes

Q5. Have you heard of a campaign or programme in your local area in the last 12 months promoting physical activity or exercise?
(please circle one number only)

Yes *(please give name/s and details)*		**1**
No	**(if NO, please go to Q7)**	**2**
Don't know		**3**

Q6. Did you participate in any events as part of the local campaign or programme? *(please circle one number only)*

Yes	**1**
No	**2**
Don't know	**3**

Q7a. Have you heard of the Devon Active Villages programme?
(please circle one number only)

Yes		**1**
No	**(if NO, please go to Q10)**	**2**
Don't know		**3**

Q7b. If Yes, what do you think the programme is about?
(please give details):

Q8. Have you participated in any events as part of the Devon Active Villages programme? *(please circle one number only)*

Yes	**1**
No	**2**
Don't know	**3**

Q9. What is your opinion of the Devon Active Villages programme?
(please circle all that apply)

I found it interesting	**1**
It's a good campaign	**2**
It was directly relevant to me	**3**
It made me think about physical activity or exercise	**4**
It seemed irrelevant to me	**5**
It's a waste of time	**6**
It's a waste of money	**7**
It had no effect on me at all	**8**
Don't know	**9**

Other (please specify):

Section 3: Your daily activities and health

Q10a. During the last 7 days, on how many days did you do vigorous physical activities? Examples of these activities include heavy lifting, digging, aerobics, running and fast bicycling.
Think about only those physical activities that you did for at least 10 minutes at a time, and do not include work activities.

Write in, put '0' if none

Days (per week) [ ]

Q10b. How much time in total did you usually spend on one of those days doing vigorous physical activities?

Write in [ ] hours [ ] minutes

Q11a. During the last 7 days, on how many days did you do moderate physical activities? Examples of moderate activities include carrying light loads, bicycling at a regular pace and social tennis.
Again, think only about those physical activities that you did for at least 10 minutes at a time. *(Do not include walking or work activities)*

Write in, put '0' if none

Days (per week) [ ]

Q11b. How much time in total did you usually spend on one of those days doing moderate physical activities?

Write in [ ] hours [ ] minutes

Q12a. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes walking at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure. *(Do not include walking you did at work)*

Write in, put '0' if none

Days (per week) [ ]

Q12b. How much time in total did you usually spend walking on one of those days?

Write in [ ] hours [ ] minutes

Q13. How would you describe your usual walking pace?
(please circle one number)

Slow	**1**
Steady	**2**
Brisk	**3**
Fast	**4**

Q14. This question is about the time you spent sitting on weekdays while travelling, at home and during leisure time. This includes time spent sitting at a computer, visiting friends, travelling on a bus, or sitting or lying down to watch television.

During the last 7 days, how much time in total did you usually spend sitting on a week day? *(Do not include time spent sitting at work)*

Write in [ ] hours [ ] minutes

Q15. Please tell us the type and amount of activity involved in your work.
(please circle one number only)

I am not in employment (e.g., retired, unemployed, studying etc.)	**1**
I spend most of my time at work sitting (such as in an office)	**2**
I spend most of my time at work standing or walking. However, my work does not require much intense physical effort (e.g., shop assistant, hairdresser, security guard, etc.)	**3**
My work involves definite physical effort including handling of heavy objects and use of tools (e.g., plumber, electrician, carpenter, cleaner, hospital nurse, gardener, etc.)	**4**
My work involves vigorous physical activity including handling of very heavy objects (e.g., scaffolder, construction worker, refuse collector, etc.)	**5**

Q16. In general, would you say your health is -
(please circle one number only)

Excellent	**1**
Very good	**2**
Good	**3**
Fair	**4**
Poor	**5**

Q17. Do you have any long-term illness, health problem or disability which limits your daily activities or the work you can do? This includes problems that are due to old age. *(please tick one box only)*

Yes ☐ No ☐

Section 4: Your opinion about daily activities

Q18. Which of the following statements best describes you?
(please circle one number only)

I am unlikely to ever do more physical activity	**1**
I intend to do more physical activity within the next month	**2**
I intend to do more physical activity within the next six months	**3**
I intend to do more physical activity, but not in the next six months	**4**
Don't know	**5**

Q19. On a scale from zero to ten….
(please circle one number on each line)

	Not at all										Very
How important is it for you to do more physical activity than you do now?	0	1	2	3	4	5	6	7	8	9	10
How confident are you that you could do more physical activity if you decided to?	0	1	2	3	4	5	6	7	8	9	10
To what extent are you trying to do more physical activity?	0	1	2	3	4	5	6	7	8	9	10

Q20. To what extent do you agree or disagree with the following?
(please circle one number on each line)

	STRONGLY AGREE	TEND TO AGREE	NEITHER AGREE NOR DISAGREE	TEND TO DISAGREE	STRONGLY DISGAREE	DON'T KNOW
My family is interested in physical activity/sport	1	2	3	4	5	6
I find it easy to have a go at physical activities	1	2	3	4	5	6
People around my village all seem to be exercising these days	1	2	3	4	5	6
I have always done some kind of physical activity	1	2	3	4	5	6
I have recently had opportunities to get involved in physical activity (e.g., classes at the village hall, walking group)	1	2	3	4	5	6
My village is a good place to be physically active	1	2	3	4	5	6
There are very few opportunities to be physically active in my village	1	2	3	4	5	6
In the last 2 years, I have been involved in regular physical activity at one time or another	1	2	3	4	5	6

Section 5: All about you

Q21. Are you male or female? *(please tick one box only)*

Male ☐ Female ☐

Q22. What is your age? *Write in* [ ] years

Q23. What is your height?

Write in

CENTIMETRES	OR	FEET	INCHES

Q24. What is your weight?

Write in

KILOGRAMS	OR	STONES	POUNDS

Q25. How many cars or vans are available for use by you and other people in this household?

Write in number
If none, write "0"

Please write in the total number of cars and vans [ ]

Q26. How many children aged 15 and under live with you?

Write in number
If none, write "0"

Please write in the number of children ***aged 15 and under*** [ ]

Q27. Do you or someone else in your household own a dog?
(please tick one box only)

Yes [ ] No [ ]

Q28. At what age did you leave full time education?

Write in number
If still in education, please enter current age

Please write in your age when you left full time education [ ]

Thank you very much for taking part. Your help is greatly appreciated. Please now return the questionnaire in the envelope provided. No stamp is required.

Appendix J. Participant information letter

SPORT AND HEALTH SCIENCES

College of Life and Environmental Sciences
St. Luke's Campus
University of Exeter
Heavitree Road
Exeter
EX1 2LU

Telephone +44 (0)1392 722807
Email es244@exeter.ac.uk
Web sshs.exeter.ac.uk

Dear Sir/Madam

Rural Devon Activities Survey

Your address has been randomly selected for this study and I am writing to ask for your help.

The Rural Devon Activities Survey is about understanding whether a regional activity programme can impact on people's activity behaviour and experiences, as well as change what people think about their local area. This study is being conducted by the University of Exeter in collaboration with Active Devon. The study received ethical approval from the College of Life and Environmental Sciences Ethical Committee in February 2011. This project has been jointly funded by the University of Exeter and the Economic and Social Research Council (ESRC).

All I ask is that one adult member of the household (aged 18 and over) would kindly complete the included survey. The survey is fairly short, and includes questions about different activities that people do and their opinions of the local area. The information provided will be treated in strict confidence in accordance with the Data Protection Act, and will only be used for statistical purposes. Included with this letter is a prepaid return envelope, which means that it will cost you nothing to return the completed survey.

Participation is voluntary but I do hope that your household will be able to help. This study is forming the main part of my research degree, and I really need as many responses as possible, so I would be extremely grateful to those individuals who choose to complete the survey. The views of those who take part will be very important in developing our understanding of how people's activities vary across rural Devon. The findings from this study will be published both nationally and internationally, and will be presented to policy makers in your local area, so this is a chance to voice your opinion.

There is a chance that you will be asked to complete the same survey in the future, or have previously been asked to complete the survey. This is because we are measuring changes over time in your area. We would really appreciate it if one person from the household completed the survey on each of these occasions.

If you would like any further information or have any questions, please contact me (Emma Solomon) by phone or email (Tel: 07899986841, Email: es244@ex.ac.uk). Thank you in advance for your help. Your cooperation will help me to ensure that this important study is a success.

Yours faithfully,

Emma Solomon

How was I chosen?

A random sample of addresses have been selected from a list kept by the Post Office of all addresses in Great Britain. This ensures that the people invited to take part in the survey are representative of the whole region. The findings will not identify you or your household. Your address will not be passed to anyone outside the research team at the University of Exeter.

Who should take part?

This survey should be completed by one adult member of the household (aged 18 and over). Please do not pass it on to another household. If there is more than one adult in the household, please choose the adult who has most recently had their birthday to complete the survey (if they are not available, please can the adult who has second most recently had their birthday complete the survey).

I do not do very much – are you sure you want to survey me?

We are interested in everybody's day-to-day activities, however much or little they do. Otherwise we will not get a true picture of what people do in rural Devon.

What does the survey involve?

The questions are all about your lifestyle and your local area so they are interesting and easy to answer. You will also be asked for some background information about yourself and your household. The survey is not long. It should take about 10-15 minutes to complete. Please use blue or black pen.

Most of the questions can be answered by circling an number like this –

Example: Yes (1)
No 2

Or like this:

STRONGLY AGREE	TEND TO AGREE	NEITHER AGREE NOR DISAGREE	TEND TO DISAGREE	STRONGLY DISGAREE	DON'T KNOW
1	2	3	(4)	5	6

Some questions ask you to **write an answer** in a box like this -

Example: **What is your age?** *Write in* **35** years

What do I do after I have completed the survey?

When you have completed the survey, please put it in the included prepaid envelope and return it to me for **FREE.** No stamp is required.
Thank you very much for taking part.

Appendix K. Cross-sectional study of physical activity correlates paper

Title: Personal, social, and environmental correlates of physical activity in adults living in rural south-west England: a cross-sectional analysis

Authors

Emma Solomon[1] (es244@ex.ac.uk)

Tim Rees[1] (Tim.J.Rees@exeter.ac.uk)

Obioha C Ukoumunne[2] (O.C.Ukoumunne@exeter.ac.uk)

Brad Metcalf[1] (B.Metcalf@exeter.ac.uk)

Melvyn Hillsdon[1] (M.Hillsdon@exeter.ac.uk)

Affiliations

[1]Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter, St. Lukes Campus, Heavitree Road, Exeter, EX1 2LU, United Kingdom.

[2]PenCLAHRC, University of Exeter Medical School, Veysey Building, Salmon Pool Lane, Exeter, EX2 4LJ, United Kingdom.

Corresponding Author

Emma Solomon

Published in: International Journal of Behavioral Nutrition and Physical Activity 2013, 10:129.

Abstract

Background: Despite the health risks, physical inactivity is common. Identifying the correlates of physical activity to inform the design of interventions to reduce the disease burden associated with physical inactivity is a public health imperative. Rural adults have a unique set of characteristics influencing their activity behaviour, and are typically understudied, especially in England. The aim of this study was to identify the personal, social, and environmental correlates of physical activity in adults living in rural villages.

Methods: The study used baseline data from 2415 adults (response rate: 37.7%) participating in the first time period of a stepped-wedge cluster randomised trial, conducted in 128 rural villages from south-west England. Data collected included demographic characteristics, psycho-social factors, perception of the local environment, village level factors (percentage male, mean age, population density, Index of Multiple Deprivation, and sport market segmentation) and physical activity behaviour. Random effects ("multilevel") logistic regression models were fitted to the binary outcome whether individuals met physical activity guidelines, and random effects linear regression models were fitted to the continuous outcome MET-minutes per week leisure time physical activity, using the personal, social, environmental, and village-level factors as predictors.

Results: The following factors both increased the odds of meeting the recommended activity guidelines and were associated with more leisure-time physical activity: being male ($p=.002$), in good health ($p<.001$), greater commitment to being more active ($p=.002$), favourable activity social norms ($p=.004$), greater physical activity habit ($p<.001$), and recent use of recreational facilities ($p=.01$). In addition, there was evidence ($p<.05$) that younger age, lower body mass index, having a physical occupation, dog ownership, inconvenience of public transport, and using recreational facilities outside the local village were associated with greater reported leisure-time physical activity. None of the village-level factors were

associated with physical activity.

Conclusions: This study adds to the current literature on the correlates of physical activity behaviour by focusing on a population exposed to unique environmental conditions. It highlights potentially important correlates of physical activity that could be the focus of interventions targeting rural populations, and demonstrates the need to examine rural adults separately from their urban counterparts.

Keywords

Physical activity, Rural communities, Cross-sectional study, Multilevel modelling.

Background

Physical inactivity is ranked the fourth leading risk factor for global mortality, to which six percent of all deaths are attributable [1]. Strong evidence supports the direct relationship between physical inactivity and all-cause mortality, coronary heart disease, high blood pressure, stroke, diabetes, obesity, metabolic syndrome, colon cancer, breast cancer, and depression [2]. In fact, to reduce the risk of these diseases, adults are recommended to undertake a minimum of 150 minutes of at least moderate-intensity activity per week [2-3]. Despite this, in England, only 29% of women and 39% of men reported doing sufficient physical activity [4], and physical inactivity is costing the United Kingdom National Health Service in excess of £0.9 billion per year [5]. Additionally, in Devon, south-west England, 17% of all deaths in 2010 could have been prevented if all adults were physically active [6].

Therefore, understanding the factors that explain why some adults are regularly active while others are inactive is of utmost importance to public health research in the United Kingdom [3]. Physical activity is a complex behaviour determined by the interaction of a large number of personal, social, and environmental factors specific to populations, setting, and type of physical activity [7-8]. Furthering the understanding of the factors that influence

physical activity behaviour in specific populations will aid the development of effective, tailored intervention strategies aimed at increasing the population prevalence of physical activity.

The majority of physical activity studies to date have examined urban populations [9]. When examining the influence of residential location on physical activity, most studies have found that rural adults are less likely to meet recommended physical activity guidelines than urban adults, making rural residents appropriate targets for future physical activity interventions [10-14]. Several studies have highlighted differences between urban and rural adults. For instance, Parks et al. [12] found noticeable differences in the importance of places to exercise on physical activity behaviour. Access to parks, walking trails, and exercise equipment was found to be important for urban adults, while access to neighbourhood streets for activity, and an indoor gym were more important for rural adults [12]. Younger age, fewer barriers to leisure time activity, and social support have been reported as correlates of physical activity in urban women, compared to higher educational attainment and the presence of enjoyable scenery for rural women [11]. Residents of rural areas are also more likely than their urban/suburban counterparts to report lower social support, limited access to exercise facilities, and fewer pavements as barriers to being physically active [11-12]. Eyler [15] found that the most frequently reported barrier to being physically active among rural women was the remoteness and how rural the local area was although neither of these factors were associated with reported activity. Previous research has indicated that being too far from activity facilities is a major barrier for women living in rural areas [16-17]. Most studies that have focused on rural areas have examined communities from the United States, where it is often the case that rural dwellers are of lower socioeconomic status than urban residents [18], which may explain some of the differences in physical activity behaviour compared to urban areas. Generally in England, however, people living in rural areas are often among the most

affluent [19]. Across the south-west of England, out of the 300 most deprived areas only 11 were classified as rural [20]. Regardless, it is clear that rural populations face a unique set of challenges associated with physical activity behaviour, and they are clearly understudied in the United Kingdom. Little is known about the correlates of physical activity in adults living in rural villages in the United Kingdom and whether they are different from the correlates reported by urban residents.

The aim of this study was to identify the correlates of physical activity behaviour in adults residing in rural villages in south-west England. The association of demographic, psycho-social, perceived environmental, and village level factors with self-reported physical activity outcomes was examined.

Methods

Recruitment and participants

This study uses baseline data from the first time period of a stepped wedge cluster randomised controlled trial evaluating the effectiveness of a community-level physical activity intervention [21]. The study was conducted in 128 rural villages across Devon, south-west England, each with a population size between 500 and 2000 people. These criteria were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities they offered. The addresses of all households in Devon were purchased from a private company (Address List Utility, Arc en Ciel, Version 3.1 PAF Quarter 1, 2011) and used to generate a complete list of all households within the study villages. From the list, a random sample of households, stratified by village, was selected to receive a survey questionnaire via the post. Households were sent a questionnaire, a participant information sheet and a prepaid return envelope. The adult in each household who had most recently had a birthday was invited to complete the survey. Eligible participants were aged 18 years or over and resident in the household.

The survey consisted of 28 questions and took participants approximately 10-15 minutes to complete, based on estimates obtained during pilot work. Informed consent was implied when participants returned a completed questionnaire. In total, 2,415 adults aged 18 to 102 years returned a questionnaire and formed the sample for the study.

Measures

Physical activity

Physical activity was measured using the self-administered, short version of the International Physical Activity Questionnaire (IPAQ-SV) [22]. The IPAQ-SV includes seven items collecting information on the frequency and duration of physical activities undertaken in the previous seven days (vigorous-intensity activity, moderate-intensity activity, walking and sitting behaviour). The IPAQ-SV has been rigorously tested for reliability and validity [22-24].

Participants were categorised according to whether they did sufficient physical activity to meet the current United Kingdom physical activity guidelines (at least 150 minutes of moderate-intensity activity a week in bouts of 10 minutes or more, or at least 75 minutes of vigorous-intensity activity a week: [3]). Physical activity level was also analysed using metabolic equivalent (MET) values to calculate participants' total MET-minutes per week of moderate intensity walking, moderate intensity physical activity, and vigorous intensity physical activity, using the IPAQ-SV scoring methods for calculating physical activity levels [25].

Demographic characteristics

Participants were asked to report their gender, age, health status, dog ownership, number of children and cars in the household. These were based on questions from the Health Survey for England [4], apart from the dog ownership question that was taken from an Australian cohort study [26]. Body mass index (BMI), defined as weight (kg) divided by

height squared (m^2), was calculated from participants' self-reported height and weight.

Psychosocial factors

To assess psychosocial factors, measures were created based on a multi-national motivation for change scale [27], and a scale developed for use in an Australian cohort study [26] (Table 1). For the 'commitment to doing more physical activity' variable, the mean was calculated across the three constituent items, and the resulting variable was categorised based on the tertiles (low, moderate and high). The mean scores were calculated from the constituent items for the 'physical activity social norms', 'physical activity habit', and 'physical activity village supportiveness' variables, and then categorised into "Unfavourable" (<0), "Neutral" (0), and "Favourable" (>0).

Perceived local environmental characteristics

Perceived local environmental characteristics were measured using items previously developed for use in a United Kingdom health study, and found to have acceptable levels of test-retest reliability [28] (Table 1). Perceived proximity and use of different recreational facilities were measured in the survey using scales that were previously found to have acceptable test-retest reliability [26, 29] (Table 1). The means were calculated from the constituent items for the variables measuring 'traffic and pleasantness of surroundings', 'proximity and convenience of walking', 'safety and convenience of cycling', 'convenience of public transport', and 'safety of walking after dark', and were then categorised into "Unfavourable" (<0), "Neutral" (0), and "Favourable" (>0).

Village-level factors

Five village-level factors were examined: population density [30], mean age of villagers [31], percent of villagers that were male [30], Indices of Multiple Deprivation (higher scores indicates more deprived [32]), and the dominant Sport England Market Segmentation for each village [33]. The Sport England Market Segmentation divides the English adult

population into 19 market segments based on their sports participation, motivations, and barriers to doing more sport, allowing Local Authorities, Sport National Governing Bodies and sports clubs to profile both individuals and areas.

Sample size

Power calculations were based on the intervention study [21]. It was estimated that 10 participants would need to be recruited from each of the 128 villages at each stage of the stepped wedge trial, in order to achieve 80% power at the 5% significance level, based on detecting an increase from 25% to 30% in the proportion of participants that met the recommended activity guidelines [34]. A recent pilot for a population study of travel behaviour in the United Kingdom achieved a response rate of 20% for a short questionnaire postal survey [35]. Using this as a guide, 50 surveys were sent out to each of the 128 villages, anticipating that we would obtain at least 10 responses per village. If the number of completed questionnaires returned within three weeks of the initial mailing was insufficient for a given village, additional questionnaires were sent out to new households.

Statistical Analysis

Random effects ("multilevel") logistic regression was used to examine whether the personal, social, environmental, and village-level factors were associated with meeting the recommended physical activity guideline (binary outcome). Random effects linear regression was used to study the relationship of the same factors with MET-minutes of moderate-vigorous physical activity per week (continuous outcome). These methods take account for correlation (clustering) between responses of participants in the same village. Firstly, crude (unadjusted) models were fitted separately for each factor as the sole predictor in the analysis. Partially adjusted models were then fitted for each type of factor, using as predictors those that were significant at the 5% level in the unadjusted analyses (e.g., a model was fitted with significant personal factors only). Finally, a single fully adjusted model was fitted including

all factors of all types that were significant predictors in the partially adjusted models. Only estimates from the unadjusted and fully adjusted models are reported. The tabulated findings are based on analyses of males and females together. Tests of interaction were carried out to assess evidence of differential effects between the gender groups and where found these are commented on in the text. All analyses were carried out using Stata 12.1 software [36].

Results

Initially, 6,400 surveys were sent out, with an additional 10 surveys sent out after three weeks because two villages had not achieved their quota of 10 completed responses. The median number of completed responses per village was 18 (range 11 to 31). 2415 responses were received in total, achieving a response rate of 37.7%. The majority of respondents were female (62.7%), with a mean (SD) age of 58 years (15.2). Compared to the general population of the study villages, the study participants tended to be older (70.2% versus 59.2% aged 50 years or over), and a greater proportion were female (62.7% versus 51%). The study participants were equivalent to the general village population in terms of their Index of Multiple Deprivation scores (mean (SD) 15.8 (4.0) for both study sample and general village population). The study participants were also extremely similar to the general population in terms of the population density of the village they resided within (mean (SD) 0.62 (0.5) for the study population versus 0.64 (0.6) for the village population). Half of the participants (49.4%) were classified as either overweight or obese, and 66.9% of all respondents reported doing sufficient physical activity to meet the recommended guidelines, reporting a median (interquartile range) total MET-minutes of physical activity per week of 1,638 (0 to 3879; Table 2).

The dimensionality of the scales measuring ‘perceptions of the local area’ [28], and the ‘presence of recreational facilities within the local area’ [29] was examined using exploratory factor analysis with a varimax (orthogonal) rotation. Factor analysis examines whether the

variation in the observed variables can be explained largely by a smaller number of underlying factors. For the scale measuring perceived environmental characteristics the scree plot indicated there were three factors “Traffic and pleasantness of surroundings”, “Proximity and convenience of walking”, and “Safety and convenience of cycling”. Two original scale items (“Convenience of public transport” and “Safety of walking after dark”) were not strongly correlated with any of the factors (factor loadings <0.5) and so were treated as separate variables. Two factors were indicated for the scale measuring availability of recreational facilities in the local area. These were “Manmade sports facilities in local area” and “Natural activity facilities in local area”. The item “Community centre/village hall in local area” was treated as a separate variable, because the factor loading was less than 0.5. Composite scores were created for each of the factors, based on the mean of the items that had their primary loadings on each factor.

Meets recommended activity guidelines

The logistic regression analyses (Table 3) revealed that being male and in better health were positively associated with the odds of meeting the recommended activity guideline in the fully adjusted models. Greater commitment to doing more physical activity, favourable activity social norms and a greater physical activity habit were associated with increased odds of being active at recommended levels in the fully adjusted model. Recent use of recreational facilities was also associated with meeting the guidelines.

‘Commitment to doing more physical activity’ was the only variable found to have a significant interaction with gender (p-value for interaction = 0.043). There was little evidence of an association between commitment to doing more physical activity and meeting the recommended activity guideline for females (p=0.19). Males, however, with ‘moderate’ (adjusted OR 1.52, 95% CI: 1.03 to 2.24) or ‘high’ (adjusted OR 2.64, 95% CI: 1.59 to 4.38) commitment levels, had increased odds of meeting the guidelines, compared to those with

‘low’ commitment levels (p<0.001).

Total leisure-time physical activity

The linear regression analyses revealed that being male, under 35, of normal body mass index and in good health, were all associated with increased leisure-time physical activity (LTPA; Table 4). In terms of occupational activity, people with sitting or standing occupations did *less* MET-minutes per week of physical activity than people who were not employed. People with physical jobs did the most LTPA per week. Owning a dog was also associated with increased LTPA. Participants with moderate ‘commitment to doing more physical activity’ levels reported the least LTPA. Positive activity social norms and physical activity habits were associated with increased leisure-time physical activity. Inconvenience of public transport, and using facilities outside the local village were both associated with increased leisure-time physical activity behaviour in the fully adjusted model.

‘Convenience of public transport’ was the only variable that had a significant interaction with gender (p-value for interaction = 0.039). There was little evidence of an association between convenience of public transport and total leisure-time physical activity for females (p=0.14). Males, however, with ‘neutral’ (adjusted mean difference = -508, 95% CI: -1061 to 45) or ‘favourable’ (adjusted mean difference = -524, 95% CI: -959 to -90) opinions about the convenience of public transport did less leisure-time physical activity than those with ‘unfavourable’ opinions on the convenience of public transport (p=0.03).

Village-level factors

None of the village-level factors were significantly associated with reported leisure-time physical activity.

Ancillary analysis

An ancillary analysis was conducted for the ‘commitment to do more physical activity’ variable. It was hypothesised that the lack of association between ‘commitment to do more

physical activity' and reported physical activity was due to the majority of participants being sufficiently physically active, and therefore having low commitment levels to do more physical activity. To investigate this, the unadjusted and fully adjusted regression models were repeated with only those participants who did not report doing sufficient activity to meet the recommended guidelines (Table 5). Commitment to doing more physical activity was significantly positively associated with LTPA in the unadjusted model, but not in the fully adjusted model.

Village and individual level variance

Only 2.4% of the variation in reported leisure-time physical activity was at the village level (i.e., 97.6% was at the participant level). The fully adjusted model explained 72.6% of the between-village variation and 18.7% of the participant-level variation in physical activity.

Discussion

The purpose of this study was to examine the personal, social and environmental correlates of physical activity in rural adults from the United Kingdom. A number of variables were identified as correlates of physical activity behaviour. Gender, health status, commitment to doing more physical activity, social norms, physical activity habit and reported use of recreational facilities were all associated with both meeting the recommended guidelines and total reported LTPA. Age, BMI, occupational activity, dog ownership, locality of recreational facilities and convenience of public transport were only correlates for total LTPA.

Whilst cross-sectional data are useful for identifying associations, analyses of longitudinal data provide a stronger basis for inferring causality [37,39]. In one review, Bauman et al. [37] identified health status as one of the clearest predictors of change for physical activity behaviour in adults. There was also consistent evidence to suggest personal history of physical activity during adulthood [38-39] (similar to 'physical activity habit'), and

intention to exercise [38-40] (similar to ‘commitment to do more physical activity’), were both predictors of change for physical activity behaviour. Reviews suggest that social norms are neither associated cross-sectionally with physical activity, nor predictors of change in physical activity behaviour [37]. Therefore, findings from the present study imply that rural populations are similar to the general population in terms of the association between health status, physical activity habit, commitment to be more active, and their reported physical activity behaviour. The association between social norms and physical activity in the present study suggests, however, that social norms may be a uniquely important factor for rural populations.

Other correlates of physical activity reported in the literature are male sex [38, 40], age (negatively) [38, 40-41] and overweight (negatively) [38]. Our findings concur with this research, although age and overweight status were only associated with total leisure-time physical activity and not the likelihood of meeting the guidelines. In line with previous research, dog owners report more physical activity than people who do not own dogs [42-44].

Accessibility of recreation facilities has been found to be the most consistent environmental predictor of activity and change in physical activity behaviour in reviews [37, 39, 45-46]. In the present study, how recently participants had used recreational facilities, and the locality of facilities used, were both associated with physical activity behaviour. Logically, the more recently participants had used a recreational facility, the more likely they were to have met the recommended guidelines. Research from urban populations has found that local recreational facilities are visited more frequently than those located further away [47-48]. However, in our study the mixed outcome for locality of facilities used suggests that it is less important for rural populations where facilities are located. It may be suggested that rural adults have to travel to use facilities because there are limited facilities available within local villages. However, in fact, nearly all participants (97%) perceived there to be at least one

natural activity facility in their local area, with 61% perceiving there to be at least one man-made sports facility. It, therefore, seems that recreational facilities were available in these rural locations. Although some facilities may have been available locally, this does not necessarily mean residents used them regularly. It is plausible that if individuals had a desire to do a particular activity that was not offered locally, or had a personal preference for a certain facility, they might have been willing to travel the necessary distance. This finding warrants further investigation, in order to understand whether rural adults would benefit from more recreational facilities in their local village.

Convenience of public transport was negatively associated with leisure-time physical activity. This finding contradicts a recent review paper that found greater access to public transport to be positively associated with walking behaviour [49]. This may be due in part to the limited public transport services available in rural Devon, with 59% of participants reporting unfavourable responses for the convenience of public transport. Additionally, this study only measured convenience of public transport, rather than use. Thus, it may be that individuals who regularly used public transport also did more walking than individuals who did not.

Strengths and limitations

Two key strengths of this study are the large sample size (n=2,415), and the random selection of participants. Additionally, the study examined a range of personal, social and perceived environmental factors, in addition to village-level factors. Although this study forms part of a longitudinal study, the data presented here are cross-sectional and, therefore, can only be used to examine associations rather than to draw inferences regarding causality. Despite being better than anticipated, and comparing well with other survey studies from the United Kingdom (15.9% [28], 17% [35]), the response rate was low (37.7%). This raises concerns that those who consented may not represent the wider population (non-response bias) [50].

However, the participants in the present study were similar to the wider population in terms of IMD score and the population density of the village they resided in. Compared to the wider population, however, the survey respondents tended to be older, with a greater proportion being female. Previous research suggests females and older adults are often over-represented in health surveys [4]. Two-thirds of the population reported meeting the recommended guidelines, suggesting that those of higher activity levels tend to be over-represented. Whilst an unrepresentative sample is compromised when estimating a mean or prevalence, such data are generally robust for examining relationships between variables, in this case between physical activity and potential correlates. A further limitation of this study is the use of self-reported data. We used established and validated measures where possible, but although the IPAQ-SV has been found to have acceptable levels of test-retest reliability (r=0.76) [23], recent reviews have questioned the levels of criterion validity (ρ=0.30, 95% CI 0.23 to 0.36 [22]; median ρ=0.29, range 0.09 to 0.39 [24]). Self-report measures of physical activity tend to include bias due to social desirability and participants may find it difficult to recall activities from the past seven days. The fact that self-reported height and weight were used to calculate body mass index is another limitation, because of social desirability bias to over-report height and under-report weight [51]. Despite this, Goodman and Strauss [52] stated that self-report measures are acceptable in epidemiological studies given that self-report measures are correlated with measured height and weight. Finally, participants were not asked about their ethnic origin in the questionnaire. This was, however, a deliberate decision, because only 2.5% of the rural population of Devon is from non-white British ethnic groups [53].

Implications

Despite the noted limitations, our findings are important from a public health perspective, in terms of understanding the unique characteristics of rural populations, through

focusing on the personal, social, and environmental correlates of physical activity. Regular physical activity plays a key role in reducing the risk factors for several chronic conditions. Therefore, the identification of physical activity correlates may help researchers, clinicians, and health policy makers to design population-specific interventions. This study adds to the limited research available on physical activity in rural communities from England. The results from the present study suggest that rural populations are similar to urban populations in terms of the correlates of physical activity behaviour. However, our findings do imply that social norms may be more influential for rural populations, compared to their urban counterparts. Contradictory to research from urban populations, there was a negative association between convenience of public transport and physical activity, and the most active individuals used recreational facilities exclusively outside of their local area. These findings suggest that rural and urban adults differ in terms of the way they interact with their environment, and that differences in the built environment have an influence on physical activity behaviour. To successfully change physical activity prevalence in rural populations, interventions should be tailored to modify the correlates of physical activity behaviour that are specific to rural adults, as identified in the present study.

Future research

Future research should focus on longitudinal studies with rural populations to examine the determinants of physical activity behaviour, to aid the understanding of the causal role and direction of effect of correlates. It is also recommended that the physical activity correlates from this and other similar studies be used to help develop future physical activity interventions specifically tailored to rural communities, and that rigorous evaluation methods be undertaken to determine the effectiveness of such programmes.

Conclusions

This study aimed to examine the personal, social and environmental correlates of

physical activity behaviour in rural adults from south-west England. Both individual and village-level predictors were included in the analysis, with gender, health, commitment to being more active, activity habits, social norms, and use of recreational facilities revealed as the clearest correlates of physical activity behaviour. Although most of the results were in line with previous research, this study did highlight some unique characteristics of the rural population. Understanding the correlates that influence physical activity behaviour is important for the designing of effective physical activity interventions, but generally the relationship between these correlates is complex and typically understudied, especially in rural populations.

List of abbreviations

BMI – Body mass index

IPAQ-SV – International Physical Activity Questionnaire – Short Version

LTPA – Leisure-time physical activity

MET – Metabolic equivalent

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

The study's chief investigators ES, MH and TR were responsible for identifying the research question, the design of the study, obtaining ethics approval and the acquisition of funding. OCU contributed to the fine-tuning of the methodology and conducted the randomisation procedures. ES carried out the data collection and processing. OCU, BM, MH and ES contributed to the statistical analysis. All authors helped draft and revise the manuscript and approved the final version.

Authors' information

[1]Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter, St. Lukes Campus, Heavitree Road, Exeter EX1 2LU, United Kingdom.

[2]PenCLAHRC, Peninsula College of Medicine and Dentistry, University of Exeter, Veysey Building, Salmon Pool Lane, Exeter, United Kingdom.

Acknowledgements

We thank Active Devon for their support of the research project. This research was supported by the Economic and Social Research Council under its Capacity Building Clusters Award (RES-187-24-0002). The research was also funded by the National Institute for Health Research (NIHR) Collaborations for Leadership in Applied Health Research and Care (CLAHRC). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health.

References

[1] World Health Organization: **Global Health Risks: Mortality and burden of disease attributable to selected major risks.** Geneva: World Health Organization; 2009.

[2] World Health Organization: **Global Recommendations on Physical Activity for Health.** Geneva: World Health Organization; 2010.

[3] Department of Health, Physical Activity, Health Improvement and Protection: **Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers.** London: Department of Health; 2011.

[4] Craig R, Mindell J, Hirani V: **Health Survey for England 2008, Volume 1: Physical activity and fitness.** London: National Centre for Social Research; 2009.

[5] Scarborough P, Bhatnagar P, Wickramasinghe KK, Allender S, Foster C, Rayner M: **The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 NHS costs.** *J Public Health* 2011, **May:**1-9.

[6] Public Health England: developed and supported by SWPHO, Sustrans and the South

West Public Health training scheme **[www.apho.org.uk/addons/-122359/atlas.html]**.

[7] Sallis JF, Owen N: **Ecological models.** In: *Health Behaviour and Health Education: Theory, Research, and Practice*. 2nd Edition. Edited by Glanz KM, Lewis F, Rimer BK. San Francisco: Jossey-Bass; 1997:403-424.

[8] Oliveira-Brochado A, Oliveira-Brochado F, Quelhas Brito P: **Effects of personal, social and environmental factors on physical activity behavior among adults.** *Rev Port Saude Publica* 2010, **28**(1):7-17.

[9] Yousefian A, Hennessy E, Umstattd MR, Economos CD, Hallam JS, Hyatt RR, Hartley D: **Development of the Rural Active Living Assessment Tools: measuring rural environments.** *Prev Med* 2010, **50**(S1):S86-92.

[10] Brownson RC, Eyler AA, King AC, Brown DR, Shyu YL, Sallis JF: **Patterns and correlates of physical activity among US women 40 years and older.** *Am J Public Health* 2000, **90**(2):264-270.

[11] Wilcox S, Castro C, King AC, Housemann R, Brownson RC: **Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States.** *J Epidemiol Community Health* 2000, **54:**667–672.

[12] Parks SE, Housemann RA, Brownson RC: **Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States.** *J Epidemiol Community Health* 2003 **57:**29–35.

[13] Bertrais S, Preziosi P, Mennen L, Galan P, Hercberg S, Oppert J-M: **Sociodemographic and geographic correlates of meeting current recommendations for physical activity in middle-age French adults: the Supplementation en Vitamines et Mineraux Antioxydants (SUVIMAX) Study.** *Am J Public Health* 2004, **94**(9):1560-1566.

[14] Martin SL, Kirkner GJ, Mayo K, Matthews CE, Durstine JL, Hebert JR: **Urban, rural, and regional variations in physical activity.** *J Rural Health* 2005, **21:**239-244.

[15] Eyler AA: **Personal, social, and environmental correlates of physical activity in rural Midwestern white women.** *Am J Prev Med* 2003, **25**(3 Suppl 1):86-92.

[16] Brownson RC, Housemann RA, Brown DR, Jackson-Thompson J, King AC, Malone BR, Sallis JF: **Promoting physical activity in rural communities: walking trail access, use, and effects.** *Am J Prev Med* 2000, **18**(3):235–241.

[17] Eyler AA, Matson-Koffman D, Evenson K, Sanderson B, Thomson J, Wilbur J, Wilcox S, Rohm-Young D: **Environmental, policy, and cultural barriers to physical activity in a diverse sample of women: The Women's Cardiovascular Health Network Project – Summary and Discussion.** *Women Health* 2002, **36**(2):123–134.

[18] Singh GK: **Area Deprivation and Widening Inequalities in US Mortality, 1969-1998.** *Am J Public Health* 2003, **93:**1137-1143.

[19] Department for Communities and Local Government: **English indices of deprivation 2010: Statistics on relative levels of deprivation in England.** London: Department for Communities and Local Government; 2011.

[20] Oxford Consultants for Social Inclusion (OCSI): **Rural deprivation in the South West.** London: Oxford Consultants for Social Inclusion; 2009.

[21] Solomon E, Rees T, Ukoumunne OC, Hillsdon M: **The *Devon Active Villages Evaluation* (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England.** *BMC Public Health* 2012, **12**:581.

[22] Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P: **International physical activity questionnaire: 12-country reliability and validity.** *Med Sci Sports Exerc* 2003, **35:**1381–1395.

[23] Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U: **A systematic review of reliability and objective criterion-related validity of physical activity questionnaires.** *Int*

J Behav Nutr Phys Act 2012, **9:**103.

[24] Lee PH, Macfarlane DJ, Lam TH, Stewart SM: **Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review.** *Int J Behav Nutr Phys Act* 2011, **8:**115.

[25] International Physical Activity Questionnaire: **Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ): Short and Long Forms.** 2005, **[www.ipaq.ki.se]**.

[26] Burton NW, Oldenburg B, Sallis JF, Turrell G: **Measuring psychological, social, and environmental influences on leisure-time physical activity among adults.** *Aust N Z J Public Health* 2007, **31:**36-43.

[27] Miller WR, Johnson WR: **A natural language screening measure for motivation to change.** *Addict Behav* 2008, **33:**1177–1182.

[28] Ogilvie D, Mitchell R, Mutrie N, Petticrew M, Platt S: **Perceived characteristics of the environment associated with active travel: development and testing of a new scale.** *Int J Behav Nutr Phy Act* 2008, **5:**32.

[29] Sallis JF, Johnson MF, Calfas KJ, Caparosa S, Nichols JF: **Assessing perceived physical environmental variables that may influence physical activity.** *Res Q Exercise Sport* 1997, **68:**345–351.

[30] Office for National Statistics: **2011 Census [http://www.ons.gov.uk/ons/guide-method/census/2011/index.html]**.

[31] Devon County Council **[http://www.devon.gov.uk/]**.

[32] English Indices of Deprivation **[https://www.gov.uk/government/publications/english-indices-of-deprivation-2010]**.

[33] Sport England **[http://www.sportengland.org/research/market_segmentation.aspx]**.

[34] Hussey MA, Hughes JP: **Design and analysis of stepped wedge cluster randomized**

trials. *Contemp Clin Trials* 2007, **28:**182–191.

[35] Sahlqvist S, Song Y, Bull F, Adams E, Preston J, Ogilvie D: **Effect of questionnaire length, personalisation and reminder type on response rate to a complex postal survey: randomised controlled trial.** *BMC Med Res Methodol* 2011, **11**.

[36] StataCorp. **Stata Statistical Software: Release 12.** College Station, TX: StataCorp LP; 2011.

[37] Bauman A, Reis RS, Sallis JF, Wells JC, Loos RJF, Martin BW, for the Lancet Physical Activity Series Working Group: **Correlates of physical activity: why are some people physically active and others not?** *Lancet* 2012, **380:**258-271.

[38] Trost SG, Owen N, Bauman AE, Sallis JF, Brown W: **Correlates of adults' participation in physical activity: review and update.** *Med Sci Sports Exerc* 2002, **34**(12): 1996-2001.

[39] Van Stralen MM, de Vries H, Muddle AN, Bolman C, Lechner L: **Determinants of initiation and maintenance of physical activity among older adults: a literature review.** *Health Psychol Rev* 2009; **3:**147-207.

[40] Rhodes RE, Martin AD, Taunton JE, Rhodes EC, Donnelly M, Elliot J: **Factors associated with exercise adherence among older adults: an individual perspective.** *Sports Med* 1999; **28:**397-411.

[41] Kaewthummanukul T, Brown KC: **Determinants of employee participation in physical activity: critical review of the literature.** *AAOHN J* 2006; **54:**249.

[42] Cutt H, Giles-Corti B, Knuiman M, Burke V: **Dog ownership, health and physical activity: A critical review of the literature.** *Health Place* 2007, **13:**261-272.

[43] Cutt H, Giles-Corti B, Knuiman M, Timperio A, Bull F: **Understanding Dog Owners' Increased Levels of Physical Activity: Results From RESIDE.** *Am J Public Health* 2008, **98**(1):66-69.

[44] Sehatzadeh B, Noland RB, Weiner MD: **Walking frequency, cars, dogs, and the built environment.** *Transportation Research Part A: Policy and Practice* 2011, **45:**741–754.

[45] Humpel N, Owen N, Leslie E: **Environmental factors associated with adults participation in physical activity: a review.** *Am J Prev Med* 2002; **22:**58-69.

[46] Wendel-Vos W, Droomers M, Kremers S, Brug J, van Lenthe F: **Potential environmental determinants of physical activity in adults: a systematic review.** *Obes Rev* 2007; **8:**425-440.

[47] McCormack GR, Giles-Corti B, Bulsara M, Pikora TJ: **Correlates of distances traveled to use recreational facilities for physical activity behaviors**. *Int J Behav Nutr Phy* 2006, **3:**18.

[48] Hoehner CM, Brennan Ramirez LK, Elliott MB, Handy SL, Brownson RC: **Perceived and objective environmental measures and physical activity among urban adults.** *Am J Prev Med* 2005, **28:**105-116.

[49] Rissel C, Curac N, Greenaway M, Bauman A: **Physical Activity Associated with Public Transport Use – A Review and Modelling of Potential Benefits.** *Int J Environ Res Public Health* 2012, **9**(7):2454-2478.

[50] Delgado-Rodriguez M, Llorca J: **Bias.** *J Epidemiol Community Health* 2004, **58:**635-641.

[51] Rowland ML: **Self-reported weight and height.** *Am J Clin Nutr* 1990, **52**(6):1125-1133.

[52] Goodman E, Strauss RS: **Self-reported height and weight and the definition of obesity in epidemiologic studies.** *J Adolesc Health* 2003, **33:**140 –141.

[53] Office for National Statistics: **2011 Census, Population and Household Estimates for England and Wales.** 2012.

Table 1. Survey measures
Psychosocial factors

Commitment to doing more physical activity (3 items – rated from 0 “not at all” to 10 “very much so” [28])	
	How important is it for you to do more physical activity than you do now?
	How confident are you that you could do more physical activity if you decided to?
	To what extent are you trying to do more physical activity?
Physical activity social norms (2 items – rated from -2 “strongly disagree” to +2 “strongly agree” [25])	
	My family is interested in physical activity/sport
	People around my village all seem to be exercising these days
Physical activity habit (3 items - rated from -2 “strongly disagree” to +2 “strongly agree” [25])	
	I find it easy to have a go at physical activities
	I have always done some kind of physical activity
	In the last 2 years, I have been involved in regular physical activity at one time or another
Physical activity village supportiveness (3 items - rated from -2 “strongly disagree” to +2 “strongly agree” [25])	
	I have recently had opportunities to get involved in physical activity
	My village is a good place to be physically active
	There are very few opportunities to be physically active in my village
Perceived local environmental characteristics	
Perceptions of the local area (5 factors)	
	Traffic and pleasantness of surroundings (4 items - rated from -2 “strongly disagree” to +2 “strongly agree”[26])
	It is pleasant to walk in the local area
	There is a lot of traffic noise in the local area
	There is little traffic in the local area
	It is safe to cross the road in the local area
	Proximity and convenience of walking (4 items - rated from -2 “strongly disagree” to +2 “strongly agree” [26])
	There is a park within walking distance
	The nearest shops are too far to walk to
	There are no convenient routes for walking in the local area
	There are no pavements in the local area
	Safety and convenience of cycling (2 items - rated from -2 “strongly disagree” to +2 “strongly agree” [26])
	The roads are dangerous for cyclists in the local area
	There are convenient routes for cycling in the local area
	Convenience of public transport (1 item - rated from -2 “strongly disagree” to +2 “strongly agree” [26])
	Safety of walking after dark (1 item – rated from -2 “strongly disagree” to +2 “strongly agree” [26])
Presence of recreational facilities within the local area (3 factors)	
	Manmade sports facilities in local area (4 items – responses 1 “yes” versus 2 “no” [25])
	Sporting club/recreation centre/gym

	Public swimming pool
	Public tennis/squash courts
	Indoor sports facilities (e.g., sports hall)
	Natural activity facilities in local area (3 items – responses 1 “yes” versus 2 “no” [25])
	Walking routes/footpaths
	Local park/public green space
	River/beach/waterfront
	Community centre/village hall in local area (1 item – responses 1 “yes” versus 2 “no” [25])
Use of recreational facilities (8 items – responses 0 “no, not in the last year”, 1 “yes, in last 12 months” or 2 “yes, in last month” [27])	
	Walking routes/footpaths
	Local park/public green space
	Sporting club/recreation centre/gym
	River/beach/waterfront
	Public swimming pool
	Public tennis/squash courts
	Indoor sports facility (e.g., sports hall)
	Community centre/village hall
Locality of facilities used (8 items – response box for participant to name location of facility used [27])	
	Walking routes/footpaths
	Local park/public green space
	Sporting club/recreation centre/gym
	River/beach/waterfront
	Public swimming pool
	Public tennis/squash courts
	Indoor sports facility (e.g., sports hall)
	Community centre/village hall

Table 2. Descriptive characteristics (N=2415)		%
Personal Factors		
	Males	37.3
	Age, y	
	18-34	6.8
	35-49	23.5
	50-64	35.7
	65+	34.5
	BMI, kg/m2	
	Normal weight (18-25)	50.6
	Overweight (25-29.99)	35.6
	Obese (≥30)	13.8
	Health	
	Poor/Fair	17.9
	Good	33.9
	Very Good/Excellent	48.2
	Participants with a long-term illness or disability	28.7
	Full-time education leaving age, y	
	16 & Under	37.6
	17-18	25.8
	19+	36.6
	Occupational activity	
	Not employed	49.8
	Sedentary/Standing job	36.1
	Physical job	14.2
	Cars in household	
	No cars	3.9
	1 car	38.5
	2 or more cars	57.5
	Households with children U15	21.5
	Households with dogs	39.2
Social Factors		
	Commitment to doing more physical activity (tertiles)	
	Low	35.9
	Moderate	34.1
	High	30.1
	Physical activity social norms	

	Unfavourable	27.5
	Neutral	23.4
	Favourable	49.1
	Physical activity habit	
	Unfavourable	23.8
	Neutral	8.5
	Favourable	67.7
	Physical activity village supportiveness	
	Unfavourable	49.2
	Neutral	22.8
	Favourable	28.1
Environmental Factors		
	Traffic and pleasantness of surroundings	
	Unfavourable	12.6
	Neutral	12.3
	Favourable	75.2
	Proximity and convenience of walking	
	Unfavourable	37.2
	Neutral	15.7
	Favourable	47.1
	Safety and convenience of cycling	
	Unfavourable	32.8
	Neutral	36.9
	Favourable	30.3
	Convenience of public transport	
	Unfavourable	59.0
	Neutral	13.9
	Favourable	27.2
	Safety of walking after dark	
	Unfavourable	26.2
	Neutral	16.0
	Favourable	57.8
	Manmade sports facilities in local area (at least one)	61.3
	Natural activity facilities in the local area (at least one)	97.3
	Community centre/village hall in local area	79.1
	Use of recreational facilities	
	No facilities used	6.5

	Used in last year only	9.5
	Used in last month	84.0
	Locality of facilities used	
	No facilities used	15.2
	Local village only	24.2
	Outside local village only	13.7
	Both local and not local	46.9
Village-level Factors		
	Population density (residents per hectare), mean (SD)	0.6 (0.5)
	Mean age, (SD)	45.8 (3.3)
	% Males in village (tertiles)	
	Low	35.6
	Moderate	32.1
	High	32.4
	Indices of Multiple Deprivation (IMD)	
	More deprived than median score for villages in Devon	49.6
	Sport England Segmentation	
	3 (Chloe)	6.9
	6 (Tim)	48.8
	8 (Jackie)	0.5
	11 (Philip)	2.0
	13 (Roger & Joy)	10.3
	17 (Ralph & Phyllis)	27.2
	19 (Elsie & Arnold)	4.3
Physical Activity		
	Meets recommended guidelines	66.9
	MET-minutes/week (total LTPA), median (IQR)	1638 (0 to 3879)

Table 3. Odds ratios for meeting physical activity guidelines – logistic regression							
			Unadjusted			*Fully adjusted*	
Predictor Variable		*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*
Personal Factors							
	Gender			0.03			0.002
	Male		Reference			Reference	
	Female	0.82	0.69 to 0.98		0.70	0.55 to 0.88	
	Age Groups (years)			<0.001			0.54
	18-34		Reference			Reference	
	35-49	0.87	0.57 to 1.33		0.99	0.61 to 1.61	
	50-64	0.70	0.47 to 1.04		0.99	0.62 to 1.58	
	65+	0.32	0.21 to 0.48		0.82	0.50 to 1.35	
	BMI Category			<0.001			0.40
	Normal weight		Reference			Reference	
	Overweight	0.79	0.65 to 0.96		0.93	0.74 to 1.18	
	Obese	0.47	0.37 to 0.60		0.81	0.59 to 1.10	
	Health			<0.001			<0.001
	Poor/Fair		Reference			Reference	
	Good	2.83	2.23 to 3.61		1.57	1.14 to 2.17	
	Very good/Excellent	5.92	4.66 to 7.53		2.05	1.44 to 2.91	
	Long-term Illness/Disability			<0.001			0.06
	Yes		Reference			Reference	
	No	3.27	2.71 to 3.94		1.31	0.99 to 1.73	
	Education leaving age (years)			<0.001			0.98
	16 & under		Reference			Reference	
	17-18	1.58	1.27 to 1.96		1.02	0.78 to 1.34	
	19+	1.86	1.52 to 2.28		1.00	0.77 to 1.28	
	Occupation Category			<0.001			
	Not employed		Reference				
	Sitting/standing job	1.82	1.51 to 2.20				
	Physical job	2.41	1.82 to 3.20				
	Cars in Household			<0.001			0.22
	No car		Reference			Reference	
	1 car	4.11	2.55 to 6.62		1.38	0.71 to 2.66	
	2+ cars	7.74	4.82 to 12.43		1.61	0.82 to 3.17	
	Children Under15 in Household			<0.001			
	Yes		Reference				
	No	0.58	0.47 to 0.73				
	Dog Ownership			<0.001			0.15

	Yes		Reference			Reference	
	No	0.71	0.60 to 0.85		0.85	0.68 to 1.06	
Social Factors							
	Commitment to doing more physical activity			<0.001			0.002
	Low		Reference			Reference	
	Moderate	1.63	1.33 to 1.99		1.21	0.94 to 1.55	
	High	2.79	2.22 to 3.50		1.66	1.25 to 2.20	
	Physical activity social norms			<0.001			0.004
	Unfavourable		Reference			Reference	
	Neutral	1.43	1.13 to 1.80		1.05	0.79 to 1.40	
	Favourable	2.53	2.06 to 3.11		1.47	1.14 to 1.90	
	Physical activity habit			<0.001			<0.001
	Unfavourable		Reference			Reference	
	Neutral	2.17	1.57 to 3.02		1.61	1.12 to 2.33	
	Favourable	7.77	6.27 to 9.62		4.30	3.33 to 5.55	
	Physical activity village supportiveness			<0.001			
	Unfavourable		Reference				
	Neutral	1.66	1.33 to 2.07				
	Favourable	1.95	1.57 to 2.41				
Environmental Factors							
	Traffic and pleasantness of surroundings			0.04			
	Unfavourable		Reference				
	Neutral	1.15	0.83 to 1.62				
	Favourable	1.37	1.06 to 1.76				
	Proximity and convenience of walking			0.30			
	Unfavourable		Reference				
	Neutral	1.17	0.90 to 1.53				
	Favourable	0.96	0.80 to 1.16				
	Safety and convenience of cycling			0.96			
	Unfavourable		Reference				
	Neutral	1.02	0.83 to 1.25				
	Favourable	0.98	0.79 to 1.22				
	Convenience of public transport			0.18			0.64
	Unfavourable		Reference			Reference	
	Neutral	0.94	0.73 to 1.21		0.93	0.68 to 1.27	
	Favourable	0.83	0.68 to 1.01		0.89	0.70 to 1.14	
	Safety walking after dark			0.002			
	Unfavourable		Reference				
	Neutral	0.97	0.75 to 1.27				

	Favourable	1.36	1.11 to 1.66				
	Manmade sports facilities in local area			<0.001			
	1+ facility		Reference				
	No facilities	0.72	0.60 to 0.85				
	Natural activity facilities in local area			<0.001			
	1+ facility		Reference				
	No facilities	0.35	0.22 to 0.58				
	Community centre in local area			<0.001			
	Yes		Reference				
	No	0.66	0.54 to 0.82				
	Use of recreational facilities			<0.001			0.01
	No facilities used		Reference			Reference	
	Used in last year only	1.70	1.12 to 2.58		1.31	0.70 to 2.44	
	Used in last month	4.49	3.19 to 6.33		2.04	1.10 to 3.47	
	Locality of facilities used			<0.001			0.27
	No facilities used		Reference			Reference	
	Local village only	1.32	1.01 to 1.72		0.73	0.48 to 1.11	
	Outside local village	2.28	1.66 to 3.12		0.97	0.61 to 1.54	
	Local and not local	2.31	1.81 to 2.94		0.88	0.59 to 1.31	
Village-level Factors							
	Population density	1.07	0.92 to 1.27	0.36			
	Mean age	1.01	0.99 to 1.04	0.27			
	Gender (% males)			0.18			
	Low		Reference				
	Moderate	1.14	0.93 to 1.41				
	High	0.94	0.77 to 1.15				
	IMD score	0.99	0.97 to 1.01	0.47			
	Sport England Segmentation			0.48			
	S19 (Elsie & Arnold)		Reference				
	S17 (Ralph & Phyllis)	0.84	0.52 to 1.36				
	S13 (Roger & Joy)	0.69	0.41 to 1.18				
	S11 (Philip)	0.49	0.23 to 1.05				
	S8 (Jackie)	0.91	0.19 to 4.25				
	S6 (Tim)	0.72	0.43 to 1.22				
	S3 (Chloe)	0.65	0.36 to 1.18				

Table 4. Regression coefficients for MET-minutes/week physical activity (total LTPA) – linear regression							
			Unadjusted			*Fully adjusted*	
Predictor Variable		*Coeff.*	*95% CI*	*p*	*Coeff.*	*95% CI*	*p*
Personal Factors							
	Gender			<0.001			<0.001
	Male		Reference			Reference	
	Female	-519	-763 to -274		-597	-841 to -352	
	Age Groups (years)			<0.001			0.002
	18-34		Reference			Reference	
	35-49	-864	-1378 to -351		-694	-1182 to -206	
	50-64	-596	-1088 to -103		-368	-843 to 108	
	65+	-1249	-1744 to -754		-787	-1318 to -255	
	BMI Category			<0.001			0.02
	Normal weight		Reference			Reference	
	Overweight	-540	-804 to -277		-365	-618 to -111	
	Obese	-879	-1232 to -525		-195	-540 to 151	
	Health			<0.001			<0.001
	Poor/Fair		Reference			Reference	
	Good	939	601 to 1278		505	153 to 857	
	Excellent/Very good	1765	1444 to 2086		836	481 to 1190	
	Long-term Illness/Disability			<0.001			
	Yes		Reference				
	No	947	687 to 1208				
	Education leaving age (years)			0.004			
	16 & under		Reference				
	17-18	449	146 to 752				
	19+	379	103 to 654				
	Occupation Category			<0.001			<0.001
	Not employed		Reference			Reference	
	Sitting/standing job	-84	-341 to 173		-526	-831 to -222	
	Physical job	1274	921 to 1627		530	147 to 912	
	Cars in Household			<0.001			
	No car		Reference				
	1 car	1143	516 to 1770				
	2+ cars	1627	1009 to 2244				
	Children Under15 in Household			0.98			
	Yes		Reference				
	No	-4	-292 to 285				

	Dog Ownership			<0.001			0.03
	Yes		Reference			Reference	
	No	-527	-770 to -284		-262	-501 to -23	
Social Factors							
	Commitment to doing more physical activity			0.002			0.03
	Low		Reference			Reference	
	Moderate	-114	-398 to 170		-317	-599 to -36	
	High	403	111 to 696		18	-286 to 322	
	Physical activity social norms			<0.001			<0.001
	Unfavourable		Reference			Reference	
	Neutral	474	140 to 807		154	-170 to 478	
	Favourable	1096	813 to 1379		513	228 to 799	
	Physical activity habit			<0.001			<0.001
	Unfavourable		Reference			Reference	
	Neutral	814	361 to 1267		447	-16 to 910	
	Favourable	2245	1974 to 2516		1557	1244 to 1870	
	Physical activity village supportiveness			<0.001			
	Unfavourable		Reference				
	Neutral	409	109 to 708				
	Favourable	553	273 to 833				
Environmental Factors							
	Traffic and pleasantness of surroundings			0.06			
	Unfavourable		Reference				
	Neutral	-139	-618 to 339				
	Favourable	257	-110 to 624				
	Proximity and convenience of walking			0.02			
	Unfavourable		Reference				
	Neutral	397	37 to 757				
	Favourable	-83	-351 to 185				
	Safety and convenience of cycling			0.14			
	Unfavourable		Reference				
	Neutral	109	-176 to 395				
	Favourable	304	-1 to 608				
	Convenience of public transport			0.06			0.04
	Unfavourable		Reference			Reference	
	Neutral	-25	-382 to 332		-52	-391 to 287	
	Favourable	-336	-619 to -52		-348	-617 to -80	
	Safety walking after dark			0.003			0.22

	Unfavourable		Reference			Reference	
	Neutral	-224	-601 to 152		-90	-451 to 271	
	Favourable	304	24 to 585		164	-108 to 436	
	Manmade sports facilities in local area			0.06			
	1+ facility		Reference				
	No facilities	-240	-493 to 14				
	Natural activity facilities in local area			0.02			
	1+ facility		Reference				
	No facilities	-864	-1592 to -135				
	Community centre in local area			0.003			0.11
	Yes		Reference			Reference	
	No	-450	-749 to -152		-239	-527 to 50	
	Use of recreational facilities			<0.001			0.05
	No facilities used		Reference			Reference	
	Used in last year only	69	-530 to 668		-126	-833 to 580	
	Used in last month	1083	605 to 1561		351	-294 to 997	
	Locality of facilities used			0.001			0.007
	No facilities used		Reference			Reference	
	Local village only	43	-344 to 429		-263	-714 to 189	
	Outside local village	775	330 to 1220		297	-198 to 791	
	Local and not local	318	-30 to 666		-286	-709 to 137	
Village-level Factors							
	Population density	20	-242 to 281	0.88			
	Mean age	14	-28 to 56	0.52			
	Gender (% males)			0.24			
	Low		Reference				
	Moderate	294	-49 to 636				
	High	125	-218 to 469				
	IMD score	3	-32 to 39	0.85			
	Sport England Segmentation			0.38			
	S19 (Elsie & Arnold)		Reference				
	S17 (Ralph & Phyllis)	-46	-779 to 688				
	S13 (Roger & Joy)	-127	-948 to 695				
	S11 (Philip)	-567	-1810 to 676				
	S8 (Jackie)	1091	-1187 to 3369				
	S6 (Tim)	-260	-1064 to 544				

	S3 (Chloe)	-652	-1592 to 288	

Table 5. Regression coefficients for MET-minutes/week physical activity (participants who didn't meet the recommended guidelines) – linear regression						
		Unadjusted			*Fully adjusted*	
Predictor Variable	*Coeff.*	*95% CI*	*p*	*Coeff.*	*95% CI*	*p*
Commitment to doing more physical activity			<0.001			0.19
Low		Reference			Reference	
Moderate	47	15 to 80		10	-26 to 46	
High	99	60 to 137		40	-4 to 85	

Appendix L. Devon Active Villages Evaluation study paper

The Devon Active Villages Evaluation (DAVE) trial of a community-level physical activity intervention in rural south-west England: a stepped wedge cluster randomised controlled trial

Emma Solomon, Tim Rees, Obioha C Ukoumunne, Brad Metcalf, Melvyn Hillsdon

Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter, St Luke's Campus, Heavitree Road, Exeter, EX1 2LU, United Kingdom
Emma Solomon
PhD Researcher

Sport and Health Sciences, University of Exeter
Tim Rees
Senior Lecturer

PenCLAHRC, University of Exeter Medical School, Veysey Building, Salmon Pool Lane, Exeter, EX2 4LJ, United Kingdom
Obioha C Ukoumunne
Senior Lecturer in Medical Statistics

Sport and Health Sciences, University of Exeter
Brad Metcalf
Senior Lecturer

Sport and Health Sciences, University of Exeter
Melvyn Hillsdon
Associate Professor of Exercise and Health Behaviour

Correspondence to: E Solomon E.Solomon@exeter.ac.uk

Abstract

Objective: To evaluate whether a community-level physical activity intervention increases the activity levels of rural communities.

Design: Stepped wedge cluster randomised controlled trial design.

Setting: 128 rural villages (clusters) from south-west England randomised to receive the intervention in one of four time periods between April 2011 to December 2012.

Participants: 10,412 adults aged 18-102 years.

Intervention: The Devon Active Villages intervention provided villages with 12 weeks of physical activity opportunities for all age groups, including at least three different types of activities per village. Each village received an individually tailored intervention, incorporating a local needs led approach. Support was provided for a further 12 months following the intervention to help sustain the intervention activities.

Main outcome measures: All 128 villages were measured at each of five data collection periods using a postal survey. The primary outcome of interest was the proportion of adults that reported sufficient physical activity to meet the current guidelines (≥150mins of moderate-and-vigorous – or ≥75mins of vigorous – intensity activity per week). The number of minutes spent in moderate-and-vigorous activity per week was analysed as a secondary outcome. Other secondary outcomes included physical activity habits and intentions, and the perceived availability and use of recreational facilities in the village.

Results: 10,412 adults (4693 intervention, 5719 control) completed the postal survey (response rate 32.2%). The intervention did not increase the odds of adults meeting the physical activity guideline (adjusted OR 1.02, 95% CI: 0.88 to 1.17; P=0.80), although there was weak evidence of an increase in the minutes of moderate-and-vigorous-intensity activity per week (adjusted mean difference= 171, 95% CI: -16 to 358; P=0.07). There were improvements in the reported physical activity habits of the villagers during the intervention

period (OR 1.18, CI 1.04 to 1.34; P=0.009). The ineffectiveness of the intervention may have been due to its low penetration—only 16% of intervention participants reported being aware of the intervention and just 4% reported participating in intervention events.

Conclusions: A community-level physical activity intervention providing tailored physical activity opportunities to rural villages did not improve physical activity levels in adults. Greater penetration of such interventions needs to be achieved for them to have any chance of increasing the prevalence of physical activity at the community level.

Trial Registration: Current Controlled Trials ISRCTN37321160

WHAT IS ALREADY KNOWN ON THIS SUBJECT

Prevalence of physical inactivity is high despite it leading to increased risk of all-cause mortality, coronary heart disease, stroke, type 2 diabetes, obesity, cancer and mental health problems

Pragmatic community-level physical activity interventions are routinely delivered using public funds, yet it is unclear whether such programmes work as they are rarely or poorly evaluated

Rural populations are generally understudied in terms of their physical activity participation, especially in the United Kingdom.

WHAT THIS STUDY ADDS

The intervention did not improve adherence to recommended physical activity levels, although there was weak evidence of improvement in the number of minutes of moderate-to-vigorous physical activity. Low intervention penetration may underlie the lack of evidence for an intervention effect.

Robust evaluation designs, such as stepped wedge, are feasible if new learning about the effectiveness of community level physical activity interventions is to be achieved.

Future interventions need to invest as much resource in the promotion of the intervention as the delivery of it.

Introduction

Leading a physically active lifestyle reduces the risk of all-cause mortality, cardiovascular disease, type 2 diabetes, and some cancers, and can improve musculoskeletal health, control body weight, and reduce symptoms of depression [1]. In order to achieve such benefits, adults are recommended to undertake a minimum of 150 minutes of at least moderate-intensity physical activity per week [2-3]. Despite this, in the Health Survey for England 2008, only 39% of men and 29% of women reported doing sufficient physical activity [4]. Based on this evidence, interventions to increase physical activity levels are now considered to be as important to population health as interventions to lower tobacco use or reduce blood pressure [3]. Fortunately substantial health benefits can be achieved through relatively modest changes in physical activity among large segments of the population [5].

Physical activity is a complex behaviour determined by the interaction of a large number of personal, social, and environmental factors [6-8]. In order to change population prevalence, interventions need to be both effective and reach large numbers of people. The majority of physical activity interventions have been delivered at the level of the individual, aimed at changing personal behaviour [9], whereas, it is community-level interventions that have the potential to produce long-lasting benefits for the whole community [10]. To date, evaluations of community-level interventions have typically used weak study designs, such as uncontrolled, pre-post evaluations, and are therefore unable to attribute any observed changes to the intervention [11]. A 'Behaviour Change' report by the House of Lords [9] noted that pragmatic community-level interventions funded by public money are routinely delivered with little or no evaluation. The report states that there is no excuse for weak evaluations, with the recommendation that rigorous evaluation plans should be in place before interventions are funded [9]. Although randomised controlled trials are considered the most powerful

design for evaluating interventions [12], they tend to focus on individuals rather than communities, such that traditional randomised controlled trials are not always reproducible in the real world [13]. In contrast, cluster randomised trials, which randomise groups (e.g., communities) and measure outcomes on individuals within those groups, may be more appropriate for evaluating interventions that are by necessity delivered to groups rather than individuals [9, 14]. As an alternative to the traditional parallel groups design, in which clusters are randomised to either an intervention or control arm, the stepped wedge trial design [15] allows the staggered delivery of an intervention to all trial clusters over a number of time periods, with clusters crossing over from the control to intervention arm. Stepped wedge designs are beneficial when an intervention cannot be delivered to many clusters at the same time, or when it would be unethical to withhold the intervention because it is strongly believed the intervention will do more good than harm [16].

Although 20% of the English population (approximately 10 million people) live in non-urban locations [4], rural populations are generally understudied [17-18]. Studies examining the influence of residential location on physical activity have generally found that rural adults are less likely than urban adults to meet recommended activity guidelines, suggesting rural residents are appropriate targets for future physical activity interventions [19-23]. Compared to their urban counterparts, rural residents are more likely to report lower social support and limited access to exercise facilities as barriers to being physically active [20-21]. Other barriers reported by rural women include the remoteness of the environment they live in, how rural the local area is [24], and being too far away from activity facilities [25-26]. It is clear that rural populations face a unique set of challenges associated with physical activity behaviour, and yet they have received very little research attention to date, especially in the United Kingdom. The aim of the present research was to evaluate the effectiveness of a community-level

physical activity intervention—‘Devon Active Villages’—using a stepped wedge cluster randomised trial design.

Methods

The data presented are from a stepped wedge cluster randomised controlled trial design evaluating *Devon Active Villages*, a community-level physical activity intervention in south-west England. The study design and sampling have been described in detail elsewhere [27].

Participants

The research took place in the seven rural regions of Devon, south-west England. Villages with populations of 500–2000 formed the sampling frame for the intervention. The range of eligible population sizes were set so that villages were large enough to have local facilities suitable for physical activity, but limited in the amount of activity opportunities they could offer. The first period (stage) took the form of a baseline period, where no villages received the intervention. The intervention was administered sequentially to 128 villages over the subsequent four time periods (see Figure 1). The time period in which villages first received the intervention was randomised (stratified by region) using computer generated random numbers. The number of villages that were to receive the intervention at each period in each village was pre-specified by Active Devon, placing further restriction on the allocation. Twenty-two villages received the intervention in the second period (April-June 2011), 36 in the third period (September-November 2011), 35 in the fourth period (April-June 2012), and 35 in the fifth period (September-November 2012).

Data collection for the evaluation took the form of a postal survey conducted at five fixed time points: baseline (in the month prior to commencement of the first intervention period) and within a week of the end of each of the four intervention periods. A repeated cross-sectional design was employed, in which a random sample of

households within each cluster was selected to receive the survey at each period. The addresses of all households in participating villages were purchased from a private company (Address List Utility, Arc en Ciel, Version 3.1 PAF Quarter 1, 2011), and the order in which households were approached to participate in the survey at each period was randomly generated. Households were sent a questionnaire, a participant information sheet, and a prepaid return envelope. The adult in each household who had most recently had a birthday was invited to complete the survey. Eligible participants were aged 18 years or over and resident in the household. The survey consisted of 28 questions and, based on estimates obtained during pilot work, took participants approximately 10-15 minutes to complete.

Intervention

Devon Active Villages was designed and coordinated by Active Devon, the countywide partnership for sport and physical activity. The Devon Active Villages Evaluation (DAVE) was conducted by the University of Exeter in close liaison with Active Devon. The primary objective of the Devon Active Villages intervention was to improve participation in physical activity by offering people of all ages increased opportunities to experience the enjoyment of sport and physical activity.

The intervention was implemented and coordinated locally by local delivery partners, including District Authority Sports Development Teams and community-based charitable organisations. Each local delivery partner delivered the intervention in one of seven rural regions of Devon. It was necessary to have different delivery partners for each area due to the large number of villages that received the intervention in each period, and because the villages were spread across the whole county. Each delivery partner was given strategic support from Active Devon as well as a clear framework and timescales around the delivery of the intervention.

Each village received a ‘community engagement phase’ for twelve weeks prior

to the main intervention. During this phase, delivery partners engaged with the local people and community groups to carry out a needs assessment and an assessment of the activities currently on offer. This often included local people being directly surveyed to find out what activities they wanted the Devon Active Villages intervention to provide. The intervention then delivered twelve weeks of physical activity opportunities for people of all ages, with each village receiving at least three different types of activities (e.g., basketball for primary school children, multi-sports sessions for adolescents, and fitness classes for adults). The activity sessions were subsidised using intervention funds. Delivery partners coordinated delivery of the intervention by finding suitable activity venues, purchasing necessary equipment, and hiring local experts to deliver the activities. Community volunteers were recruited to help run the activities and were provided with mentoring support throughout the intervention. Delivery partners supported the villages for twelve months following the intervention, providing them with specialist support, regular mentoring, as well as additional funding and equipment as required to help sustain the intervention activities.

Outcomes

The primary outcome was the proportion of participants who reported sufficient physical activity to meet the recommended physical activity guidelines, compared between the intervention and control modes as a binary outcome. A key secondary outcome was the total number of metabolic equivalent (MET) minutes per week, from which the primary outcome was derived. In addition to the above, the following outcomes were also examined: physical activity social norms, physical activity habits, perceived village supportiveness for physical activity, commitment to doing more physical activity, physical activity intentions, availability of recreational facilities in the local area, reported use of recreational facilities, and the locality of facilities used.

Measures

Demographic characteristics

Participants were asked to report their gender, age, age when left full-time education, and cars in the household, based on questions from the Health Survey for England [4].

Physical activity

Physical activity was measured using the short version of the International Physical Activity Questionnaire (IPAQ-SV) [28]. The IPAQ-SV includes seven items on the frequency and duration of physical activities undertaken in the previous seven days (vigorous intensity activity, moderate intensity activity, walking, and sitting behaviour). The IPAQ-SV has been rigorously tested for test-retest reliability and criterion validity [28-29].

Participants were categorised according to whether they reported sufficient physical activity to meet the current United Kingdom physical activity guidelines (at least 150 minutes of moderate intensity activity per week in bouts of 10 minutes or more, or at least 75 minutes of vigorous intensity activity per week) [3]. Physical activity level was also analysed using MET values to calculate participants' total MET-minutes per week of moderate intensity walking, moderate intensity physical activity, and vigorous intensity physical activity, using the IPAQ-SV scoring methods for calculating physical activity levels [30].

Psychosocial factors

To assess psychosocial factors, measures were created based on a multi-national motivation for change scale [31], and scales developed for use in an Australian cohort study [32], and an English physical activity pilot programme [33] (Table 1). Any negatively worded items were recoded so that higher scores were positive. Each item assessing physical activity social norms was dichotomised ("strongly disagree/disagree/neither" versus "strongly agree/agree"). The means for the 'physical

activity habits' and 'perceived village supportiveness for physical activity' were taken, and the percentage of participants who scored equivalent to 1 or above (i.e., equivalent to "agree" or above) was calculated. The percentage of participants intending to do more activity within the next month or six months (as opposed to "not within the next six months" or "unlikely to ever") was compared between the intervention and control modes. Participants' 'commitment to doing more physical activity' was calculated as the mean of three constituent items, and then analysed as a continuous measure.

Perceived local environmental characteristics

Perceived proximity and use of different recreational facilities were measured using scales previously found to have acceptable test-retest reliability [32,34] (Table 1). Of the items assessing participants' awareness of recreational facilities, only the four facilities that we would have expected to be impacted on by the intervention ('walking routes/footpaths', 'local park/public green space', 'indoor sports facilities', and 'community centre/village hall') were analysed as binary outcomes. Participants were grouped according to whether they had used at least one of the eight recreational facilities within the "last month", in contrast to the "last 12 months" or "not at all". Participants were also grouped according to whether they had used facilities in the "local village only" or "both inside and outside the village", as opposed to "outside village only" or "not at all".

Devon Active Villages awareness and participation

Participants were asked whether they were aware of the Devon Active Villages intervention, and if so, whether they had participated in any of its events. Participants who were aware of the intervention were also asked to select the response items that most accurately reflected their opinions of the intervention (responses included 'I found it interesting', 'It's a good campaign', 'It was directly relevant to me', 'It made me

think about physical activity or exercise', 'It seemed irrelevant to me', 'It's a waste of time', 'It's a waste of money', and 'It had no effect on me at all').

Village-level factors

Village-level factors were obtained from the 2011 Census [35], including percentage of villagers who were male, age classification for adult villagers, and population density. Index of Multiple Deprivation (IMD) score was obtained at the Lower Layer Super Output Area level [36]. Data on the penetration of the Devon Active Villages intervention were obtained from Active Devon. Everyone who participated in the intervention was required to complete a registration form before commencing activity. From the registration details, the proportion of the population from each of the study villages attending an event was calculated, both for the whole village population and the adult population (aged 17 years or over).

Sample size

To detect an increase from 25% to 30% of people meeting the guidelines for recommended physical activity levels, with 80% power at the 5% significance level, we recruited ten participants from each of the 128 villages at each study period. The sample size was calculated using formulae presented by Hussey and Hughes [16] and takes account of both within-village clustering and the number of villages receiving the intervention at each stage. The intra-cluster (intra-village) correlation coefficient (ICC) for the primary outcome was assumed to be 0.02 based on published ICCs for three physical activity-related outcomes at the postcode sector level, estimated using data from the 1994 Health Survey for England [37].

A recent pilot for a population study of travel behaviour in the UK achieved a response rate of 20% for a short questionnaire postal survey [38]. On this basis, 6,400 surveys were sent out at every stage (50 surveys to each village), with the expectation that at least 1,280 would be completed and returned. When this response rate was not

achieved within three weeks of surveys being posted, an additional five surveys were sent out to extra households for every one survey missing. It is possible that some individuals would receive the questionnaire more than once. In such cases, if returned, demographic variables (gender, age, height, weight) were used to identify this.

Statistical analysis

For all outcomes, the data collected across the five periods were used in a single analysis. Analyses applied the intention-to-treat principle, with participants analysed according to the trial mode their village (cluster) was in for the stage at which they provided outcome data. Unadjusted and confounder-adjusted comparisons of the outcomes between intervention and control modes were implemented using random effects ("multilevel") linear regression, estimated using maximum likelihood [39] for continuous outcomes, specifying the village effect as random; and marginal logistic regression models using Generalised Estimating Equations (GEEs) with information sandwich ("robust") estimates of standard error for binary outcomes, specifying the correlation structure as exchangeable [40]. The random effects model and GEE methods allowed for the correlation between the outcomes of participants in the same village cluster, as is required for cluster randomised trials. For binary outcomes, when the intra-cluster (intra-village) correlation coefficient (ICC) was negative, instead of presenting the GEEs estimates, odds ratios from *ordinary* logistic regression were used. All analyses included stage as a predictor. Adjusted models also included the following prognostic factors: region, gender, and age at the stage of data collection. The ICC of the outcome was reported based on the confounder-adjusted analyses. In addition, an exploratory test of interaction was used to assess whether the effect of the intervention differed across the seven regions, a proxy for local delivery partner. All analyses were carried out using Stata software, version 12.

Results

Of the 32,315 surveys that were sent out, 10,412 were completed and returned (response rate 32.2%, range 30.3% at wave four to 37.7% at wave one). Of these, 38.8% were male, and the mean (SD) age was 58 (15) years. Compared to the general population of the intervention villages, the study participants tended to be older (71.9% versus 59.2% aged 50 years or over), and a greater proportion were female (61.2% versus 51%). The study participants were extremely similar to the general village population in terms of their IMD scores (mean (SD) 15.8 (4.0) for both populations), and the population density of the village they resided within (mean (SD) 0.63 (0.5) for the study population versus 0.64 (0.6) for the village population). 4,693 participants provided data in the intervention trial mode and 5,719 in the control mode. The sample characteristics were similar between the intervention and control mode participants, with comparable responses being reported for gender, age, education leaving age, and car ownership (Table 2). A greater proportion of the intervention participants were in the least deprived quintile (25.7%) than the control participants (21.3%), similarly more controls (22.2%) than intervention participants (15.8%) were in the most deprived quintile.

There was little evidence of an intervention effect on meeting the recommended physical activity guidelines (adjusted OR: 1.02; 95% CI: 0.88 to 1.17; p=0.80; Table 3; Table 4), and uncertainty over the true size of the difference between intervention and control participants regarding metabolic equivalent minutes per week (adjusted mean difference: 171; 95% CI: -16 to 358; p=0.07). At one extreme the intervention may have had no effect on MET minutes per week, while at the other extreme it is plausible that the intervention improved physical activity levels by up to 358 metabolic equivalent minutes per week (equivalent to 90 minutes of moderate-intensity physical activity). Physical activity habits did differ between trial modes, with a greater percentage of the intervention participants having favourable activity habits than the control mode (51.5%

versus 47.5%; adjusted OR: 1.18; 95% CI: 1.04 to 1.34; p=0.009). There were no between group differences in physical activity social norms, perceived village supportiveness for physical activity, intentions or commitment to doing more physical activity, awareness of local walking routes/footpaths, local parks/public green space, indoor sports facilities or a local community centre/village hall, and use and locality of recreational facilities.

There was little evidence that the effect of the intervention was modified by study area (interaction test p=0.62). Post-hoc analyses also showed there was little evidence that the intervention had a delayed effect (p=0.79) or an immediate effect that subsided (p=0.98).

Of the study participants in the intervention mode 16% reported awareness of Devon Active Villages, and 4% reported participation in intervention events (Table 5). Of those reporting awareness of the intervention, 50.6% agreed it was a good campaign, 29.8% found the intervention interesting, and 25.1% reported that the intervention made them think about physical activity or exercise. In total, 80% of the opinions on the Devon Active Villages intervention were positive.

Intervention registrations

In the intervention villages, 5.2% of the population registered to participate in Devon Active Villages events (Table 6), although when children (aged 16 years and under) were excluded, this figure was reduced to 2.7%. Greatest participation in Devon Active Villages activities occurred in the villages that received the intervention in the second time period for the adult population (4.3%). Several villages failed to participate in the intervention, while others achieved up to 48% population penetration.

Discussion

The aim of this study was to evaluate the effectiveness of Devon Active Villages, a community-level physical activity intervention delivered to rural villages. The Devon

Active Villages intervention had no effect on the proportion of people active at recommended levels, and there was uncertainty regarding the true size of the increase in the number of MET-minutes per week reported, as reflected in the 95% confidence interval for the mean difference. It is possible that the intervention was simply ineffective at changing behaviour, or if it was effective at the individual level, the low levels of population penetration prevented any observable effect at the village level.

Ensuring sufficient penetration and reach across a community to attain a population-level impact is one of the most difficult aspects of community-level interventions [10]. Although few studies reported population participation rates, one review found that the highest exposures were obtained for public information and screening activities rather than more intensive interventions, and that population penetration rates ranged from 4-60% [10].

Baker et al. [11] conducted a systematic review of community-level physical activity interventions and found that only three out of the 25 included studies reported positive changes in physical activity behaviour [41-43]. Jiang et al. [41] conducted an intervention in urban communities within Beijing, finding a reported increase in regular physical activity in the intervention group (adjusted relative risk 1.20, 95% CI 1.09 to 1.31). However, the intervention achieved substantial penetration within the community (73% participation), through ‘door-to-door’ hand-outs and individualised counselling by health practitioners. In the Finnmark Intervention study [42], a sport and activity-based intervention in a small artic community in Norway, males reported a significant increase (p=0.047) in physical activity behaviour six years after the initial baseline measurement. No change was found in the female population, however. Similar to the Beijing study, the Finnmark Intervention reached large segments of the population, through community engagement, mass media, and individual counselling. The only other study in the review to find an increase in physical activity was the Rockhampton 10,000 Steps

Project [43], where the proportion of females who met the recommended guidelines increased significantly from baseline to post-intervention. The study found no evidence of physical activity behaviour change in males. Again this intervention involved a large number of components, including social marketing, pedometers, individual counselling, partnering with local organisations, and environmental changes.

In contrast, the studies that reached a smaller proportion of the population, either through low cost or low activity, found no intervention effect on physical activity [11]. For example, the low cost of one intervention in rural municipalities in Denmark limited the amount of intervention activities that took place, resulting in the intervention being purely mass-media [44]. Simon et al. [45] was one example of a low reach intervention, aimed at school communities in France. Although the intervention initially aimed to reach the whole community, in actuality, the vast majority of the intervention activities were targeted at one specific section of it. This was similar to Devon Active Villages, where many of the intervention activities were targeted at a specific group within the community (i.e., basketball for primary school children, or armchair aerobics for older adults). From the population penetration rates achieved by Devon Active Villages, it is clear that the intervention would be classed as ‘low reach’. Therefore, the results of the present investigation are in line with previous research, where interventions with low reach failed to have an effect on physical activity behaviour [11].

Despite the above, the intervention was associated with stronger activity habits, suggesting that those in the intervention mode perceived themselves to be physically active, but did not report a greater level of physical activity than controls. Physical activity habits were the only outcome for which there was evidence of an effect. We are not aware of any other community interventions that have reported physical activity habit as an outcome.

The majority of reported intervention opinions were positive, suggesting that the intervention was well-received by the small proportion of participants who were aware of its existence.

Strengths and limitations

Strengths of the study include the large sample size (>10,000) and the large number of participating villages. Incorporating multiple data collection stages into the research meant that it was possible to analyse both whether the intervention had an immediate effect on physical activity that later subsided, or whether the intervention effect was delayed. Each village acted as its own control, meaning communities were not subjected to "best-fit" matching with control communities. Another strength is that the time-period in which villages first received the intervention was randomly allocated, eliminating any selection bias. Indeed, in a recent review of community-level physical activity interventions [11], only one study out of 25 used randomisation to allocate communities [45].

This study fills a gap in the literature by being the first to use a stepped wedge cluster randomised trial design to evaluate a physical activity intervention. Examples of previous stepped wedge investigations include examination of the efficacy of Hepatitis B vaccinations [46], the effect of housing improvements on respiratory health symptoms [47], and different tuberculosis treatments on number of disease episodes [48]. The stepped wedge trial design was the most appropriate study design for this intervention for three reasons: first, there was a necessity to deliver the intervention in waves due to limited resources; second, once the intervention was implemented it was never fully taken away; and third, the intervention was delivered to all eligible communities of a certain size within the county [16]. Despite the stepped wedge trial design requiring greater data collection and longer trial duration [16], it was

successfully able to capture the effect of a pragmatic community-level physical activity intervention.

Despite being better than anticipated, and comparing well with other survey studies from the United Kingdom (15.9% [49], 17% [38]), the response rate was low (32.2%). Non-response bias often occurs in survey studies, where non-responders may differ in some way from those who do respond [50]. The participants in the present research were similar to the wider population in terms of IMD score and the population density of the village they resided in. Compared to the wider population, however, the survey respondents tended to be older, with a greater proportion being female. Previous research suggests females and older adults are often over-represented in health surveys [4]. Survey respondents also tend to report being healthier and doing more physical activity than the general population [51]. Two-thirds of the present research population reported meeting the recommended guidelines, suggesting that those of higher activity levels were over-represented. However, previous research suggests that the IPAQ-SV has a tendency to over-report time spent doing physical activity [52-54], with one review finding that the IPAQ-SV over-reported physical activity on average by 106% (Range 36-173%) [54].

Individuals may have over-reported exposure to the Devon Active Villages intervention events because they believed this response to be favourable to the researchers [48]. However, the high level of consistency between the reported participation and participation according to village registrations suggests that such reporting bias was not present in this study. In addition, whilst the generally positive intervention opinions may have been an accurate representation of how well the intervention was received, participants may have reported overly positive opinions in an attempt to stop any intervention funding from being withdrawn [50].

The main limitation of this research is the use of self-reported data. Self-reported outcome measures of physical activity tend to include bias due to social desirability and may lead to some misclassification, with some participants finding it difficult to recall activities from the past seven days. Nevertheless, there is no reason to believe that any misclassification was systematically different with regard to intervention or control group. Furthermore, established and validated measures were used where possible (e.g., the IPAQ-SV to measure physical activity). Repeated cross-sectional samples of participants were used in this research in order to measure the community-level impact of the intervention on physical activity levels, rather than follow individuals over time to detect individual changes in behaviour. Although it is possible that the repeated cross-sectional samples included people new to the village who were not exposed to the intervention, it is perhaps more likely that there was contamination due to people in control villages participating in neighbouring village intervention activities. Both of these factors would have attenuated intervention effects [10]. Finally, it may be that the reach, intensity and duration of the intervention were insufficient to achieve a population-level impact.

Implications

The results of this research indicate that unless community-level physical activity interventions can reach a substantial proportion of the target population they are unlikely to be able to change the population prevalence of physical activity. This research also demonstrated that it is possible to rigorously evaluate pragmatic community-level physical activity interventions using novel research techniques. This research is also the first to use a stepped wedge cluster randomised trial design to evaluate a community-level physical activity intervention. The stepped wedge design was suitable for evaluating the Devon Active Villages intervention, because it was by necessity delivered in waves, administered to all eligible communities in the population,

and, once a community received the intervention, it was never fully taken away. This study also adds to the limited research available on physical activity in rural communities from England.

Future research

It is advocated that future evaluation studies consider the use of the stepped wedge cluster randomised trial design for evaluating health interventions, especially for community-level physical activity interventions. Additionally, more rigorous evaluations of community-level physical activity interventions are needed to help understand what works in altering population prevalence. In order to improve validity and reliability, these intervention evaluations should include objective measurements (e.g., accelerometry data). Finally, more research is warranted on how to achieve greater community penetration/engagement in community-level physical activity interventions.

Conclusions

An experimental approach to the design and evaluation of the Devon Active Villages intervention showed no evidence that the intervention increased the prevalence of physical activity within the villages, and only weak evidence of an increase in physical activity level. The intervention did lead to an increase in physical activity habits. The evaluation highlighted that very few residents were even aware of and participated in the intervention. Evaluating population-level interventions is challenging but not impossible. Better understanding of the effectiveness of such interventions will only be achieved if more community-level interventions, which continue to be funded, are evaluated with more robust research designs. Future interventions need to both deliver effective interventions and achieve a high level of reach to achieve changes in population prevalence.

Copyright for authors

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, a worldwide licence to the Publishers and its licensees in perpetuity, in all forms, formats and media (whether known now or created in the future), to i) publish, reproduce, distribute, display and store the Contribution, ii) translate the Contribution into other languages, create adaptations, reprints, include within collections and create summaries, extracts and/or, abstracts of the Contribution, iii) create any other derivative work(s) based on the Contribution, iv) to exploit all subsidiary rights in the Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

Competing interests

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that (1) [initials of relevant authors] have support from [name of company] for the submitted work; (2) [initials of relevant authors] have [no or specified] relationships with [name of companies] that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have [specified] financial relationships that may be relevant to the submitted work; and (4) [initials of relevant authors] have no [or specified] non-financial interests that may be relevant to the submitted work.

Details of contributors

ES designed the study and data collection tools, obtained ethics approval, acquired funding, carried out the data collection, cleaned and analysed the data, and drafted and revised the paper. She is guarantor. TR identified the research question, designed the study, acquired funding, and revised the draft paper. OCU fine-tuned the research methodology, conducted the randomisation procedures, analysed the data, and revised

the draft paper. BM analysed the data, and revised the draft paper. MH identified the research question, designed the study, acquired funding, analysed the data, and drafted and revised the paper.

Ethics approval

Ethical approval for this study was obtained from the University of Exeter ethics committee (Proposal A2 04/05/11). Recipients of the survey were made aware that their participation was voluntary; therefore informed consent was implied when participants returned a completed questionnaire.

Sources of funding

This research was supported by the Economic and Social Research Council under its Capacity Building Clusters Award (RES-187-24-0002). As part of the Economic and Social Research Council PhD CASE Studentship grant, the research was partially funded by Active Devon, but the research work and results are completely independent and not biased by the opinions of Active Devon. The research was also funded by the National Institute for Health Research (NIHR) Collaborations for Leadership in Applied Health Research and Care (CLAHRC). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health.

Data access

All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study, and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing

Data sharing: no additional data available.

Study protocol paper

Solomon E, Rees T, Ukoumunne OC, Hillsdon M. The Devon Active Villages Evaluation (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England. BMC Public Health 2012;12:581. URL: http://www.biomedcentral.com/1471-2458/12/581

Supplementary files

1. Study questionnaire
2. Information form
3. Study protocol paper

References

[1] World Health Organization. Global Health Risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.

[2] World Health Organization. Global Recommendations on Physical Activity for Health. Geneva: World Health Organization; 2010.

[3] Department of Health, Physical Activity, Health Improvement and Protection. Start Active, Stay Active. A report on physical activity from the four home countries' Chief Medical Officers. London: Department of Health; 2011.

[4] Craig R, Mindell J, Hirani V. Health Survey for England 2008, Volume 1: Physical activity and fitness. London: National Centre for Social Research; 2009.

[5] Kohl HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, Kahlmeier S, for the Lancet Physical Activity Series Working Group. The pandemic of physical inactivity: global action for public health. The Lancet. 2012;380(9838):294-305.

[6] Sallis JF, Owen N. Ecological models. In: Health Behaviour and Health Education: Theory, Research, and Practice. 2nd Edition. Edited by Glanz KM, Lewis F, Rimer BK. San Francisco: Jossey-Bass; 1997:403-24.

[7] Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults'

participation in physical activity: review and update. Med Sci Sports Exerc. 2002;34(12):1996-2001.

[8] Oliveira-Brochado A, Oliveira-Brochado F, Quelhas Brito P. Effects of personal, social and environmental factors on physical activity behavior among adults. Rev Port Saude Publica. 2010;28(1):7-17.

[9] House of Lords: Science and Technology Select Committee. Behaviour Change. London: Authority of the House of Lords; 2011.

[10] Merzel C, D'Affilitti J. Reconsidering Community-Based Health Promotion: Promise, Performance, and Potential. Am J Public Health 2003;93(4):557-74.

[11] Baker PRA, Francis DP, Soares J, Weightman AL, Foster C. Community wide interventions for increasing physical activity. Cochrane Db Syst Rev 2011. 2011;(Issue 4).

[12] Sibbald B, Roland M. Understanding controlled trials: Why are randomised controlled trials important? Brit Med J. 1998;316:201.

[13] Sanson-Fisher RW, Bonevski B, Green LW, D'Este C. Limitations of the Randomized Controlled Trial in Evaluating Population-Based Health Interventions. Am J Prev Med. 2007;33:155–61.

[14] Craig P, Dieppe P, Macintyre SJ, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: new guidance. Medical Research Council; 2008.

[15] Cook TD, Campbell D. Quasi-experimentation: Design and analysis issues for field settings. Boston: Houghton Mifflin; 1979.

[16] Hussey MA, Hughes JP. Design and analysis of stepped wedge cluster randomized trials. Contemp Clin Trials. 2007;28:182-91.

[17] Ogilvie D, Griffin SJ, Jones A, Mackett R, Guell C, Panter J, Jones N, Cohn S, Yang L, Chapman C. Commuting and health in Cambridge: a study of a 'natural experiment' in the provision of new transport infrastructure. BMC Public Health.

2010;10:703.

[18] Saelens BE, Sallis JF, Frank LD. Environmental correlates of walking and cycling: findings from the transportation, urban design and planning literatures. Ann Behav Med. 2002;25:80–91.

[19] Brownson RC, Eyler AA, King AC, Brown DR, Shyu YL, Sallis JF. Patterns and correlates of physical activity among US women 40 years and older. Am J Public Health. 2000;90(2):264-70.

[20] Wilcox S, Castro C, King AC, Housemann R, Brownson RC. Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States. J Epidemiol Community Health. 2000;54:667–72.

[21] Parks SE, Housemann RA, Brownson RC. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. J Epidemiol Community Health. 2003;57:29–35.

[22] Bertrais S, Preziosi P, Mennen L, Galan P, Hercberg S, Oppert J-M. Sociodemographic and geographic correlates of meeting current recommendations for physical activity in middle-age French adults: the Supplementation en Vitamines et Mineraux Antioxydants (SUVIMAX) Study. Am J Public Health. 2004;94(9):1560-66.

[23] Martin SL, Kirkner GJ, Mayo K, Matthews CE, Durstine JL, Hebert JR. Urban, rural, and regional variations in physical activity. J Rural Health. 2005;21:239-44.

[24] Eyler AA. Personal, social, and environmental correlates of physical activity in rural Midwestern white women. Am J Prev Med. 2003;25(3 Suppl 1):86-92.

[25] Brownson RC, Housemann RA, Brown DR, Jackson-Thompson J, King AC, Malone BR, Sallis JF. Promoting physical activity in rural communities: walking trail access, use, and effects. Am J Prev Med. 2000;18(3):235–41.

[26] Eyler AA, Matson-Koffman D, Evenson K, Sanderson B, Thomson J, Wilbur J, Wilcox S, Rohm-Young D. Environmental, policy, and cultural barriers to physical

activity in a diverse sample of women: The Women's Cardiovascular Health Network Project – Summary and Discussion. Women Health. 2002;36(2):123–34.

[27] Solomon E, Rees T, Ukoumunne OC, Hillsdon M. The Devon Active Villages Evaluation (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England. BMC Public Health. 2012;12:581.

[28] Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35:1381–95.

[29] Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. Int J Behav Nutr Phys Act. 2012;9:103.

[30] International Physical Activity Questionnaire. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ): Short and Long Forms. 2005. Available from: http://www.ipaq.ki.se.

[31] Miller WR, Johnson WR. A natural language screening measure for motivation to change. Addict Behav. 2008;33:1177-82.

[32] Burton NW, Oldenburg B, Sallis JF, Turrell G. Measuring psychological, social, and environmental influences on leisure-time physical activity among adults. Aust N Z J Public Health. 2007;31:36-43.

[33] Pringle A, Gilson N, McKenna J, Cooke C. An Evaluation of the Local Exercise Action Pilots and Impact on Moderate Physical Activity. Health Educ J. 2009;68(3);179-85.

[34] Sallis JF, Johnson MF, Calfas KJ, Caparosa S, Nichols JF. Assessing perceived physical environmental variables that may influence physical activity. Res Q Exercise Sport. 1997;68:345–51.

[35] Office for National Statistics. 2011 Census. 2011. Available from: http://www.ons.gov.uk/ons/guide-method/census/2011/index.html.

[36] English Indices of Deprivation. Available from: https://www.gov.uk/government/publications/english-indices-of-deprivation-2010.

[37] Gulliford MC, Ukoumunne OC, Chinn S. Components of variance and intraclass correlations for the design of community-based surveys and intervention studies. Am J Epidemiol. 1999;149: 876-883.

[38] Sahlqvist S, Song Y, Bull F, Adams E, Preston J, Ogilvie D. Effect of questionnaire length, personalisation and reminder type on response rate to a complex postal survey: randomised controlled trial. BMC Med Res Methodol. 2011;11.

[39] Schall R. Estimation in generalized linear models with random effects. Biometrika. 1991;78(4),719-27.

[40] Hanley JA, Negassa A, Edwardes MDdeB, Forrester JE. Statistical Analysis of Correlated Data Using Generalized Estimating Equations: An Orientation. Am J Epidemiol. 2003;157(4):364-75.

[41] Jiang B, Wang W, Wu S. The effects of community intervention measures on prevention and control of hypertension. Chin J Prev Control Chronic Non-communicable Disease. 2008;16(6):254–7.

[42] Lupton BS, Fonnebo V, Sogaard AJ. The Finnmark Intervention Study: Is it possible to change CVD risk factors by community-based intervention in an Arctic village in crisis? Scand J Public Health. 2003;31(3):178–86.

[43] Brown WJ, Mummery K, Eakin E, Schofield G. 10,000 Steps Rockhampton: Evaluation of a whole community approach to improving population levels of physical activity. J Phys Act Health. 2006;1:1–14.

[44] Osler M, Jespersen NB. The effect of a community-based cardiovascular disease prevention project in a Danish municipality. Danish Medical Bulletin. 1993;40:485–9.

[45] Simon C, Schweitzer B, Oujaa M, Wagner A, Arveiler D, Triby E, Copin N, Blanc S, Platat C. Successful overweight prevention in adolescents by increasing physical activity: a 4-year randomized controlled intervention. Int J Obes. 2008;32(10):1489-98.

[46] Gambia Hepatitis Study Group. The Gambia Hepatitis Intervention Study. Cancer Res. 1987;47:5782–87.

[47] Somerville M, Basham M, Foy C, Ballinger G, Gay T, Shute P, Barton AG. From local concern to randomised trial: the Watcombe Housing Project. Health Expect. 2002;5:127–35.

[48] Grant AD, Charalambous S, Fielding KL, Day JH, Corbett EL, Chaisson RE, DeCock KM, Hayes RJ, Churchyard GJ. Effect of routine Isoniazid preventative therapy on Tuberculosis incidence among HIV-infected men in South Africa. J Amer Med Assoc. 2005;22:2719–25.

[49] Ogilvie D, Mitchell R, Mutrie N, Petticrew M, Platt S. Perceived characteristics of the environment associated with active travel: development and testing of a new scale. Int J Behav Nutr Phy Act. 2008;5:32.

[50] Delgado-Rodriguez M, Llorca J. Bias. J Epidemiol Community Health. 2004;58:635-41.

[51] Macera CA, Jackson KL, Davis DR, Kronenfeld JJ, Blair SN. Patterns of non-response to a mail survey. J Clin Epidemiol. 1990;43(12):1427-30.

[52] Rzewnicki R, Auweele YV, De Bourdeaudhuij I. Addressing overreporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. Public Health Nutr. 2003;6(3):299-305.

[53] Ekelund U, Sepp H, Brage S, Becker W, Jakes R, Hennings M, Wareham NJ. Criterion-related validity of the last 7-day, short form of the International Physical Activity Questionnaire in Swedish adults. Public Health Nutr. 2006;9(2):258-65.

[54] Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. Int J Behav Nutr Phys Act. 2011;8(115).

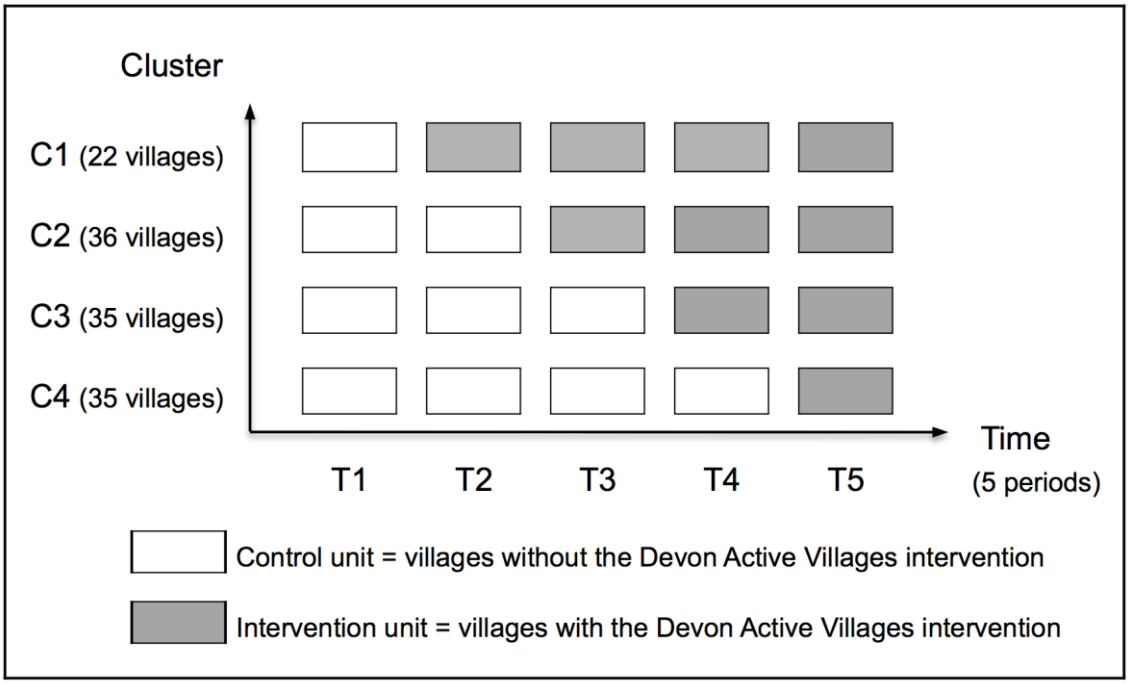


Figure 1 Design of the DAVE study. One cluster (C1, C2, C3, or C4) represents one group of intervention villages. Each time period (T1, T2, T3, T4, or T5) represents a data collection point. Each unit (control or intervention) represents one time period of one cluster.

Table 1. Survey measures

Psychosocial factors

Physical activity social norms (2 items – rated from -2 “strongly disagree” to +2 “strongly agree” [32])

My family is interested in physical activity/sport
People around my village all seem to be exercising these days

Physical activity habit (3 items - rated from -2 “strongly disagree” to +2 “strongly agree” [32])

I find it easy to have a go at physical activities
I have always done some kind of physical activity
In the last 2 years, I have been involved in regular physical activity at one time or another

Physical activity village supportiveness (3 items - rated from -2 “strongly disagree” to +2 “strongly agree” [32])

I have recently had opportunities to get involved in physical activity
My village is a good place to be physically active
There are very few opportunities to be physically active in my village

Commitment to doing more physical activity (3 items – rated from 0 “not at all” to 10 “very much so” [31])

How important is it for you to do more physical activity than you do now?
How confident are you that you could do more physical activity if you decided to?
To what extent are you trying to do more physical activity?

Intention to do more physical activity (4 response items [33])

I am unlikely to ever do more physical activity (1)
I intend to do more physical activity, but not in the next six months (2)
I intend to do more physical activity within the next six months (3)
I intend to do more physical activity within the next month (4)

Perceived local environmental characteristics

Presence of recreational facilities within the local area (8 items – responses 1 “yes” versus 2 “no” [34])

Walking routes/footpaths
Local park/public green space
Sporting club/recreation centre/gym
River/beach/waterfront
Public swimming pool
Public tennis/squash courts
Indoor sports facility (e.g., sports hall)
Community centre/village hall

Use of recreational facilities (8 items – responses 0 “no, not in the last year”, 1 “yes, in last 12 months” or 2 “yes, in last month” [32])

Walking routes/footpaths
Local park/public green space
Sporting club/recreation centre/gym
River/beach/waterfront
Public swimming pool
Public tennis/squash courts
Indoor sports facility (e.g., sports hall)
Community centre/village hall

Locality of facilities used (8 items – response box for participant to name location of facility used [32])

Walking routes/footpaths
Local park/public green space
Sporting club/recreation centre/gym
River/beach/waterfront
Public swimming pool
Public tennis/squash courts
Indoor sports facility (e.g., sports hall)
Community centre/village hall

Table 2: Sample characteristics by trial mode

Variable	Trial mode	
	Intervention (N = 4693)	**Control (N = 5719)**
Male, %	39.8	38.0
Age in years, mean (SD)	58.7 (15.3)	58.1 (15.3)
Education		
16 and under, %	36.5	38.1
17/18, %	25.8	26.3
19 and over, %	37.7	35.6
Car ownership		
No car	3.9	4.4
One car	37.8	39.2
Two or more cars	58.3	56.4
Indices of Multiple Deprivation score (quintiles, %)		
1 (lowest)	25.7	21.3
2	20.9	16.8
3	19.8	19.2
4	17.8	20.4
5 (highest)	15.8	22.2

Table 3: Comparison of outcomes between trial modes

Outcome	Trial mode		Crude comparison	Adjusted comparison		
	Intervention	*Control*	statistic	Statistic (95% CI)	p-value	ICC
Met physical activity guidelines, %	61.9	63.9	1.03	1.02 (0.88 to 1.17)	0.80	0.008
Number of metabolic equivalent minutes per week, mean (SD)	2317 (2964)	2450 (3014)	155	171 (-16 to 358)	0.07	0.010
Family is interested in physical activity (social norms), %	62.1	59.7	1.13	1.12 (0.98 to 1.26)	0.09	0.008
People around me all seem to be exercising (social norms), %	18.5	18.4	1.03	1.03 (0.87 to 1.23)	0.72	0.039
Physical activity habits, %	51.5	47.5	1.19	1.18 (1.04 to 1.34)	0.009	0.004
Perceived village supportiveness for physical activity, %	8.2	7.7	0.99	0.99 (0.78 to 1.26)	0.94	0.001
Intend to do physical activity within the next 6 months, %	61.3	57.5	0.93	0.93 (0.82 to 1.06)	0.26	0.005
Commitment to physical activity, mean (SD)	5.7 (2.6)	5.5 (2.7)	0.1	0.1 (-0.1 to 0.2)	0.33	0.006
Aware of walking routes/footpaths in the local area, %	94.0	95.0	0.95	0.89 (0.64 to 1.26)	0.52	0.029
Aware of local parks/public green space in the local area, %	80.6	78.8	1.01	1.00 (0.83 to 1.19)	0.96	0.107
Aware of indoor sports facilities in the local area, %	34.4	32.9	1.00	0.97 (0.86 to 1.10)	0.62	0.260
Aware of community centre/village hall in the local area, %	83.9	80.9	1.02	0.97 (0.80 to 1.19)	0.80	0.095
Used recreational facilities within the last month, %	84.9	85.2	0.97	0.94 (0.78 to 1.13)	0.49	0.024
Used at least one recreational facility in the village, %	71.3	72.5	0.96	0.94 (0.82 to 1.09)	0.42	0.084

The trial mode statistics are the mean scores (or overall percentage) within the mode across all five stages. A detailed breakdown of results within each stage is shown in Table 4 for '*Met physical activity guidelines'* and '*number of MET minutes per week'*. The comparative statistic is the Mean Difference for quantitative outcomes, and the Odds Ratio for dichotomous outcomes. Sample size ranged from 3892 to 4693 in the intervention mode and 4657 to 5719 in the control mode. Crude analyses adjusted for stage. Adjusted analyses adjusted for stage, gender, age, and area.

Table 4. Crude comparison of physical activity variables by stage

Stage		Trial mode	
		Intervention	**Control**
1	N	-	2,409
	Meets physical activity guidelines, %	-	66.9
	Number of MET minutes/week, mean (SD)	-	2561 (2977)
2	N	312	1,625
	Meets physical activity guidelines, %	67.3	61.5
	Number of MET minutes/week, mean (SD)	2848 (3191)	2449 (3109)
3	N	921	1,082
	Meets physical activity guidelines, %	60.0	58.8
	Number of MET minutes/week, mean (SD)	2304 (3033)	2137 (2956)
4	N	1,380	522
	Meets physical activity guidelines, %	64.6	68.2
	Number of MET minutes/week, mean (SD)	2512 (3084)	2585 (2961)
5	N	1,971	-
	Meets physical activity guidelines, %	60.1	-
	Number of MET minutes/week, mean (SD)	2101 (2785)	-
Total	N	4,584	5,638
	Meets physical activity guidelines, %	61.9	63.9
	Number of MET minutes/week, mean (SD)	2317 (2964)	2450 (3014)

N – sample size

Table 5: Participation and opinions on the DAV intervention†

Participation/opinion	%
Participated in the DAV intervention	25.0
Opinions on the DAV intervention:	
I found it interesting	29.8
It's a good campaign	50.6
It was directly relevant to me	16.2
It made me think about physical activity or exercise	25.1
It seemed irrelevant to me	7.4
It's a waste of time	1.2
It's a waste of money	2.6
It had no effect on me at all	13.0

† Sample size is the 745 (16.0%) participants from the intervention mode who were aware of the DAV intervention.

Table 6: Proportion of the population of study villages that registered as participants in the 'Devon Active Villages' intervention

Batch*	% total pop. Median (range)	% 17+ years pop. Median (range)
1	8.3 (0 to 24.8)	3.9 (0 to 20)
2	6.9 (0 to 48)	4.3 (0 to 17.7)
3	4.8 (0 to 19.2)	1.4 (0 to 13.2)
4	3.9 (0 to 23.6)	1.0 (0 to 8.3)
Overall	5.2 (0 to 48)	2.7 (0 to 20)

* Each batch of villages represents all the villages that first received the intervention in the same time period, with the village as the unit of analysis.

Appendix M. Stage 3 Active Devon Research Update

1,256 surveys returned from villages that have received the intervention, either in phase 1 or phase 2, measured at stage 3 of data collection.

Q5. Have you heard of a campaign or programme in your local area in the last 12 months promoting physical activity or exercise?

- Yes: 351 (28.1%)
- No: 849 (68%)
- Don't know: 49 (3.9%)

Q5B. If yes, how many named Devon Active Villages when asked to name details?

- Yes: 36 (10.3% of people who answered yes to Q5. Had heard of a campaign/programme.
- Others named OCRA, LED, activities in their village hall (lots of Pilates and Zumba) etc.

Q6. Did you participate in any events as part of the local campaign or programme?

- Yes: 92 (23% of the 400 who had heard of a campaign/programme or weren't sure)
- No: 303 (75.75%)
- Don't know: 5 (1.25%)

Q7A. Have you heard of the Devon Active Villages programme?

- Yes: 220 (17.6%)
- No: 1016 (81.1%)
- Don't know: 16 (1.3%)

Q7B. If Yes (heard of DAV), what do you think the programme is about?

A Devon County Council Project to help promote healthy communities through sports for everyone

A programme designed to bring fitness to rural villages where facilities are normally limited

A scheme to offer residents of Aylesbeare activities in our community

Activities

Activities in rural communities

Activities to help people to get/keep fit

Allocating funding for projects which start an activity in the parish at schools or groups

Allowing people to take more physical exercise

As above

As in title

As Q5

As well as regular exercise it momettes communication within the community

Bringing exercise classes to villages

Bringing sport to villages

Bringing sports programmes to small villages where facilities are limited

Bringing the community closer together and to bring sports facilities to the village rather than having to travel out

Bringing things out to the villages that would not happen otherwise

Bringing town activities to villages

Cant remember - arrange our own walks & exercise classes

Cant remember but I read it in Tavistock gazette

Community involvement, particularly for over 60s

Community participation in activities to the benefit of the participants and the community at large

Creating opportunities for exercise/fitness in small communities without permanent facilities?

Don't know

Don't know just saw it mentioned on a poster

Don't know, didn't read poster

Don't really know have seen some of the posters but didn't have time to stop and read them, there was a cycling one we fancied but not sure if that was Devon Active Villages

Encourage people to be active

Encourage villagers to participate in physical activities

Encouragement of sporting activities

Encouraging & funding activities in villages & providing training

Encouraging activities in rural villages

Encouraging community spirit and activities

Encouraging grass roots activity programmes

Encouraging local people in rural communities to participate in physical activities - to promote health & well-being

Encouraging local people to take more active exercise

Encouraging local people to take part in physical activity - usually in group events

Encouraging more organised fitness activities

Encouraging more participation in activities

Encouraging people to be more active and take regular exercise

Encouraging people to be more physically active

Encouraging people to become more active, slimmer in their local area

Encouraging people to take exercise

Encouraging physical activity

Encouraging physical activity for people in Devon villages by providing opportunities through local providers and councils

Encouraging sport/fitness in rural communities

Encouraging village to set-up local activities - funding available

Excellent - great idea, shame not everybody uses it

Excellent if got car to get there
Exercise
Exercise for young
Exercises in villages
Finding out if a sport/exercise activity can be set up and well attended for a particular village if there is enough interest
Fitness opportunities in rural communities or to encourage participation in fitness activity
for young people, school age, to promote fitness
Funding for community activities involving exercise
General health & well-being for life
Getting activity programmes going
Getting all areas active
Getting children & adults to increase their participation in activities to increase fitness, improve health
Getting everyone more active and making more facilities available
Getting more activities to isolated villages
Getting more people to have access to active sports
Getting people active
Getting people active & interested in village life
Getting people active in rural areas
Getting people active physically within the village
Getting people active/exercises etc
Getting people fit
Getting people in rural areas to participate more in exercise and socialising with people from the village. Encouraging healthy body & mind
Getting people in rural areas to think more about and do more physical activity
Getting people in the village active
Getting people in villages active in exercise
Getting people in villages to partake in more physical activities
Getting people interested in keeping them active
Getting people involved in activity
Getting people involved in being more active
Getting people more active
Getting people more active and involved in sport. I am applying for funding for cricket coaching in the village this summer
Getting people to be more active
Getting people to be more active physically
Getting people to exercise
Getting people to exercise more

Getting people to exercise regularly
Getting people to say what they would like activity wise in their community
Getting people together
Getting people together to be more active, do sports and exercise
Getting people up off their butts to do some enjoyable exercise! mostly for free!
Getting us all more active
Getting village people more active
Getting villages active
Getting villages involved in sporting and community activities
Giving local people the opportunity to participate in sport/activities without needing to travel to towns
Giving money away to those who ask for it (!)
Giving people living outside of the main cities an opportunity to participate in sporting activities to promote healthy living
Giving residents local facilities to keep fit
Giving villages funding to get villagers active
Great
Great!
Having local activities to take part in
Heard of it but didn't know what it involved
Helping groups make their sports more accessible
helping small communities encourage exercise for residents
Helping villages get funding to organise sports/exercise activities
I assume this is what I am referring to in q5. I understood that the idea is to increase people's physical activity
I don't really know
I have heard of it, but don't know anything about it
I have not taken much notice, since Okehampton town is so active
I've heard of 'Devon Active Villages' but what it actually is I don't know
Improving and encouraging activities for local communities
Increasing access to sport/exercise/leisure in the rural context
Increasing activity for families in villages
Increasing physical exercise for people in rural communities
Introducing people in villages to sporting activities
Involving local communities in activities and also involved with fundraising for local charities
It is a good idea
It's about encouraging people in rural areas to try a new sport/activity, in the convenience of their own village - something they probably wouldn't do if they had to travel a long way to attend a class. If they enjoy their taster sessions they may decide to look for regular classes elsewhere

Keeping fit and community
Keeping fit and healthy
Keeping village populations active - white socializing & using local facilities (physical social and emotional wellbeing)
Local sports opportunities
Localism - with a "splash of" big community
Making it more convenient to get exercise
Making participation of physical activity accessible and affordable to people living in rural settings
Money available to promote local sports clubs/activities
New initiative
No idea
Not much
Not sure
Not sure as only been here a couple of months
Not sure what it is about
Not sure, physical health classes in local villages
Not sure!
Notice in parish magazine
Participation of local people
Physical active within local community
Physical exercise
Presumably encouraging physical activities
Programme to encourage physical activities in village halls
Promoting active sports
Promoting activities in rural areas, getting the rural population more physically active. Promoting a sense of community
Promoting activities locally particularly in rural areas
Promoting an active lifestyle to improve health and well-being
Promoting an active lifestyle. Asking villagers what facilities/local activities would be beneficial/enjoyable for them.
Promoting community spirit alongside fitness programmes
Promoting exercise & sport in villages without having to travel
Promoting exercise for health
Promoting exercise in rural areas
Promoting physical activity
Promoting physical activity in the local community
Promoting physical activity in the local community with initial funding from the lottery
Promoting social/physical activity awareness in small communities

Promoting sport and leisure activities in rural villages

Promoting sport in villages

Promoting sport within the villages and keeping villages active providing ways to access Active Activities within your area

Promoting villages trying to start keep fit and exercise of any type either by funding old groups or starting new ones

Proposal announced in local parish magazine for February

Providing activities and funding for villagers looking to improve facilities

Providing assistance to set up sports clubs or activities

Providing exercise classes in rural areas

Providing facilities for rural communities

Providing funds for someone wanting to set up a club i.e physical activity

Providing more sports activities in villages eg exercise classes

Providing some free exercise classes to rural locations with view of them being adopted long term by residents

Providing sport for rural communities

Providing structured activity within Parish boundaries

Providing training, equipment etc to encourage all ages in community to try new activities

Providing village-based sport activity

Reviewing the needs of local residents

Rural locations to be supported with exercise & activities

Setting up activities tailored to the needs of the community

Setting up new local activities

Small recreation ground - ours is primarily for children - only badminton and short mat bowls are available for adults - venue at village hall

Sports & physical activity / encouraging enjoyment or sport & endorsing government policy through 'Sport England' (2008-11).

Sports activities

Sports activities for villages but not very well advertised

Sports/recreation/fitness programmes in the village

Supporting groups that want to set up physical activities in local areas

Tai Chi - Keeping older people active

Thats the one! Bringing sport & recreation to small village communities where it does not exist

The programme is not really of interest as we have active working lives

The provision of physical activities in villages in Devon

There is money available via Parish council to buy in sports/exercise equipment or programmes for all ages

To enable rural communities to establish a recreational sport to bring communities together

To encourage people exercise, either within existing group or a start up. Funding being available to cover tuition costs, hall hire etc.

To ensure the public are as active as possible

To get people moving and encourage activity

To get small communities to put on sport & dance programmes - to act as a catalyst and to provide a facilitator or expert

To promote exercise, awareness of local activities and programme's to activate the villagers and offer community activities

Tried to get villagers active and then get someone to be trained to run the sessions

Trying to get more activity in village

Using local facilities to promote exercise and train people to become leaders

Very little activity in Uplyme. Occasional plays/arts activities

Village communities working/playing together to support/educate and meet social needs of all age groups

Villages in action

Villages in Action, Local Arts Events

Walking clubs

was asked what some offered funds have been spent on criteria/methods a bit vague

Q8. Have you participated in any events as part of the Devon Active Villages programme?

- Yes: 46 (19.7%)
- No: 175 (75.1%)
- Don't know: 12 (5.2%)

Q9. What is your opinion of the Devon Active Villages programme?

- It's a good campaign: 112 (50.9% of 220 who had heard of DAV)
- I found it interesting: 66 (30%)
- It made me think about physical activity or exercise: 63 (28.6%)
- It was directly relevant to me: 38 (17.3%)
- Don't know: 36 (16.4%)
- It had no effect on me at all: 22 (10%)
- It seemed irrelevant to me: 18 (8.2%)
- It's a waste of money: 4 (1.8%)
- It's a waste of time: 1 (0.5%)

Other (please specify): 44 (20%)

- Positive: 7 (3.2%)
- Negative: 12 (5.5%)
- Neutral/Don't know: 25 (11.4%)

Other opinions

A good idea Bridford

Again, have heard of it, but there have been no activities in our local area yet	Stockland
Didn't include horse riding which is a very popular local activity	Plymtree
Do not know enough about it to form an opinion	Denbury & Torbryan
Don't know of any of these activities in Uplyme village	Uplyme
Dont know enough about it needs advert in local newsletter	Whimple
Found it very good, but was not able to continue because of disability	Rockbeare
Good idea - would get more participation if carried out at a sensible time	Malborough
Had not previously heard of it	Colaton Raleigh
Has benefitted my mother aged 75 - what about young people though?	Brixton
Hasn't actually got going in my village	Colaton Raleigh
Have not got the time farming	Lamerton
Haven't had anything about the programme in the post	Lamerton
Helped us engage with the local primary school & parents for 'supported cycling sessions	Lamerton
I already play tennis, short tennis and table tennis regularly	Aylesbeare
I am a keep fit - runner - exercise etc.	Membury
I am already very active and involved in numerous sports including coaching a local football team. Also in Crediton Swimming club, running and cricket	Crediton Hamlets
I am already very active and make extensive use of facilities in Kingsbridge which I drive to	Malborough
I am involved in a garden project which also encourages all ages to join and participate	Kenton
I am not physically able to get to Crediton sports centre. If I could swim my health would be improved but access is a problem	Copplestone
I don't know enough about it	Lamerton
I have ME and am unable to exercise, even if I wanted to - so completely irrelevant to my needs. Also people in my village are rich enough that they could fund their own activities, they don't need scarce public funds spent on them too.	Diptford
I know a cycling group has recently commenced but do not know if part of D.A.V	Stoke Gabriel
I ride, Tam parttime, muck out, garden, walk to do all above so feel I do enough	Widecombe

I think we were supposed to get a skateboard ramp but not enough villages were interested. Shame kids need something to do in a village	Plymtree
I was aware that lots of voluntary participation was needed	Lustleigh
I wasn't happy with the particular activity	Newton St. Cyres
I will be offering a class, which I would probably not be able to afford to do without backing from LED	Aylesbeare
I wish it was relevant to the over 60s	Colaton Raleigh
If it comes to my village, I would be very interested	Broadhem-bury
Intend to contribute/join this programme soon	Shebbear
It has had little impact on my village	Diptford
It hasn't happened in Denbury yet to my knowledge	Denbury & Torbryan
n/a at 90	Burrington
Not appropriate for my age and ailments	Stockland
Not started yet	Aylesbeare
Only just started advertising in my area so no real evidence of what has or is being proposed	Meavy
Programme in Sowton was abandoned due to lack of public interest. I suggested carpet bowls.	Sowton
Taking too much time to implement	East & West Buckland
The courses run close to me werent of interest, but I would have gone & used the service if there had been something offered that I enjoy.	Rockbeare
The zumba classes was only advertise through the primary school! So I was lucky to even hear about them, went to all six. I was the only one! Some people only came once, a couple twice! Sorry to say teacher not very inspiring, but difficult I know with so many different age group, but there is another Zumba class held in Holsworthy & Bude and she is always busy and her classes are pumping!	Pyworthy
Too early to comment further	Denbury &Torbryan
Very good, encourages people to be active and get involved	Tedburn St. Mary
Worthy but unable to be feasible in our tiny village	Membury

Appendix N. Stage 4 ‘other’ opinions on the Devon Active Villages programme

EAST DEVON

I have misunderstood what the campaign is. Is it given enough publicity? - Dunkeswell

It had no effect on me because a) not available in my village, b) type of activity I am interested in - Sowton

Rockbeare village too small - classes over full so didn’t go back. Not very good times for 9-5 ers. - Rockbeare

Very few activities in this village - and poor take up - Colaton Raleigh

Only saw a stall at Exeter quay on torch day - Talaton

Lotto and L.A. support for physically healthy lifestyles to promote health and bring people together. It’s just a bit annoying to discover i must have ‘log on credentials’ to explore resources on the Active Devon website. Why so? - Stoke Canon

We are a cycle shop in Honiton. We understand the programme is there to encourage village/local activity. To be honest we have not been approached once, with regard to out 10% off offer. We have a picture frame type poster in our shop window (since the beginning of the programme). No-one has ever spoken about the programme. - Payhembury

MID DEVON

I have not seen any real progress in our village - Cheriton Bishop

It is a good idea but our village has not got a village hall and no community - Copplestone

Locally available exercise but hasn’t happened here unfortunately. - Halberton

NORTH DEVON

I don’t think there is any in my village - Marwood

It’s great! - Burrington

SOUTH HAMS

Because I have severe osteo-arthritis, the local things were not relevant to me (but enjoyed by friends locally) - Malborough

However, not enough interest therefore it stopped after 4 sessions - Berry Pomeroy

Did not take off in this village as school use hall everyday. We older people don't like going out at night. - Berry Pomeroy

I loved Nordic walking (the DAV prog) and now take part in a weekly walk with the newly formed group. It has made my own walks far more fitness orientated. - Aveton Gifford

It appears to be a very good programme - If I was younger I would use it. - Thurlestone

Seemed badly organised and beaurocratic. (I am a self-personal trainer, working employed outdoors in Dartmouth area) - Strete

TEIGNBRIDGE

Activities not suitable for me - Tedburn St Mary

More for kids - Tedburn St Mary

Timing of class was too early. I couldn't get back from work & change time to attend class regularly. - Tedburn St Mary

Targeted at older people? - Tedburn St Mary

Despite canvassing the village and submitting the results to the coordinator nothing happened!! This was 2 years ago and therefore disappointing!!! - Bridford

Have heard nothing since July last year! - Bridford

Disappointed that our suggestion for a dance club in holidays was not responded to by DAV - Kenton

Great for my children and local school - Broadhempston

I filled in a form for local council and suggested that the best and cheapest method of exercise is walking, so footpaths need to be open - Whitestone

I wish we'd had access to it sooner - Stokeinteignhead

It enabled me to find an instructor for pilates - 8 miles away (nearest) - Widecombe in the Moor

Would love for zumba and salsa classes to continue - Widecombe in the Moor

TORRIDGE

Always wanted to try TaiChi, but this scheme kickstarted our engagement, and my vast improvement in health - Shebbear

I missed some activities because I didn't know they were happening. There are activities I would do, but they have not been offered. Others were tasters, & stopped. I would have continued. - Shebbear

Area specific! - Broadwoodwidger

For larger villages than ours! Devon C.C. closed our school and have not entertained our offer to but it! We could have many of the facilities promoted by Devon Active Villages! - Broadwoodwidger

As a disabled person the relevance was minimal - Black Torrington

Completed the 6 weeks, which I thoroughly enjoyed at £1/session, now to continue price will have to go up to cover no more funding. Why did we bother? Fitness is a continued process! - Black Torrington

Found it great for community spirit too - St Giles in the Wood

Nothing for teenagers and not much near St Giles at all - St Giles in the Wood
Joined the Tai Chi group at St Giles and we still meet up once a week and do it together (without instructor), other classes were available but I didn't hear of those until it was too late. - St Giles in the Wood

The class I attended was not very good - I didn't break into a sweat - St Giles in the Wood

I heard of it through work - but it wasn't in my village, or one local to me - Langtree

Offering the chance to try archery (which I did), short mat bowls (which I did), boxing (no) and other stuff - Pyworthy

WEST DEVON

Ineffective in our area - Gulworthy

Nothing known in my locality - Gulworthy

Appendix O. Stage 5 Active Devon Research Update

I have collected all my data. We have had 10,412 responses in total over 5 stages of data collection. Of those, 4,693 had received the programme at the point at which they were surveyed.

745 of these said they were aware of the DAV programme when asked (16%).

141 (3%) named Devon Active Villages unprompted – when asked whether they had heard of any programme or campaign in the local area promoting physical activity.

Table 1: Participation and opinions on the DAV programme†

Participation/opinion	**%**	**n**
Participated in the DAV programme	25.0	193
Opinions on the DAV programme:		
I found it interesting	29.8	225
It's a good campaign	50.6	384
It was directly relevant to me	16.2	122
It made me think about physical activity or exercise	25.1	188
It seemed irrelevant to me	7.4	57
It's a waste of time	1.2	11
It's a waste of money	2.6	21
It had no effect on me at all	13.0	102

† Sample size is the 745 (16.0%) participants from the intervention mode who were aware of the DAV programme.

1,110 opinions given (participants could report more than one opinion each) of which 83% were positive, 8% were negative, and 9% were that the programme had no effect.

Table 2: Sample characteristics by awareness

Variable	Awareness mode	
	Intervention (N = 4693)	Aware (N = 745)
Male, %	39.8	29.0
Age in years, mean (SD)	58.7 (15.3)	57.5 (14.1)
BMI category		
Normal weight, %	48.7	52.5
Overweight, %	36.8	34.6
Obese, %	14.6	12.8
Health		
Excellent/very good, %	47.7	53.3
Good/fair/poor, %	52.3	46.7
Education		
16 and under, %	36.5	29.9
17/18, %	25.8	28.8
19 and over, %	37.7	41.3
Car ownership		
No car	3.9	2.6
One car	37.8	32.9
Two or more cars	58.3	64.5
Physical activity – meet guidelines, %	61.9	71.6
Total LTPA, mean (SD)	2317 (2964)	2567 (2780)

Top villages aware

24 – Colaton Raleigh, Aylesbeare

20 – Berry Pomeroy

18 – Stockland, Burrington, Stoke Gabriel

17 – Shebbear, Diptford

16 – Bridford, Widecombe in the Moor, East & West Buckland, Rockbeare, Membury

Lowest villages aware

0 – Clyst St George, Beer, Musbury, Kentisbeare, Witheridge, Chittlehampton, Marwood, Bishop's Tawton, Holbeton, Blackawton.

1 – Hawkchurch, Talaton, Otterton, Upottery, Chardstock, Shobrooke, Burlescombe, Morchard Bishop, Landkey, Instow, Ermington, Bigbury, Loddiswell, West Alvington, East Allington, Staverton, Sparkwell, Shaldon, High Bickington, Bridestowe.

Table 3: Sample characteristics by participation

Variable	Participant mode	
	Intervention (N = 4693)	Participant (N = 193)
Male, %	39.8	21.6
Age in years, mean (SD)	58.7 (15.3)	56.8 (14.8)
BMI category		
Normal weight, %	48.7	51.3
Overweight, %	36.8	36.7
Obese, %	14.6	12.0
Health		
Excellent/very good, %	47.7	55.6
Good/fair/poor, %	52.3	44.4
Education		
16 and under, %	36.5	34.4
17/18, %	25.8	28.1
19 and over, %	37.7	37.5
Car ownership		
No car	3.9	3.1
One car	37.8	33.7
Two or more cars	58.3	63.2
Physical activity – meet guidelines, %	61.9	76.2
Total LTPA, mean (SD)	2317 (2964)	2642 (2566)

Top villages participating

12 – Rockbeare

11 – Burrington, East & West Buckland,

10 – Berry Pomeroy

9 – Widecombe in the Moor

7 – Aylesbeare, Shebbear

6 – Brixton, Pyworthy

Non- participating villages

Sowton, Broadhembury, Branscombe, Kilmington, Uplyme, Whimple, All Saints, Clyst St George, Beer, Dunkeswell, Hawkchurch, Musbury, Gittisham, Talaton, Otterton, Upottery, Chardstock, Culmstock, Sampford Peverell, Copplestone, Bow, Chawleigh, Cheriton Fitzpaine, Thorverton, Kentisbeare, Sandford, Shobrooke, Lapford, Burlescombe, Morchard Bishop, Bishop's Nympton, North Molton, Witheridge, Chittlehampton, Landkey, Instow, Marwood, Bishop's Tawton, Diptford, Cornwood, Kingswear, Ermington, Newton and Noss, Bigbury, Holbeton, Thurlestone, Loddiswell, Ugborough, East Allington, Blackawton, Staverton, Holcombe Burnell, Dunsford, Christow, Ide, Stokeinteignhead, Hennock, Buckland Brewer, High Bickington, Whitchurch, Okehampton Hamlets, Drewsteignton, Northlew.

Appendix P. Intervention awareness and participation by region and stage

EAST DEVON

* % aware - was the percentage of participants aware of the DAV programme from villages in East Devon that had already received the programme.

[1] % participating - was the percentage of participants who reported participating in DAV events from villages in East Devon that had already received the programme.

MID DEVON

* % aware - was the percentage of participants aware of the DAV programme from villages in Mid Devon that had already received the programme.

Phase	Intervention (N)	Control (N)	Aware of DAV (N)	Aware (%)*	Participate (N)	Participate (%)[1]
Baseline	0	607	0	0	0	0
1	85	382	27	31.8	5	5.9
2	257	250	52	20.2	10	3.9
3	320	119	49	15.3	9	2.8
4	488	0	73	15.0	10	2.0
TOTAL	*1150*	*1358*	*201*		*34*	

[1] % participating - was the percentage of participants who reported participating in DAV events from villages in Mid Devon that had already received the programme.

NORTH DEVON

* % aware - was the percentage of participants aware of the DAV programme from villages in North Devon that had already received the programme.

Phase	Intervention (N)	Control (N)	Aware of DAV (N)	Aware (%)*	Participate (N)	Participate (%)[1]
Baseline	0	326	0	0	0	0
1	64	200	3	4.7	0	0
2	117	153	13	11.1	2	1.7
3	217	73	18	8.3	1	0.5
4	274	0	20	7.3	2	0.7
TOTAL	*672*	*752*	*54*		*5*	

[1] % participating - was the percentage of participants who reported participating in DAV events from villages in North Devon that had already received the programme.

SOUTH HAMS

Phase	Intervention (N)	Control (N)	Aware of DAV (N)	Aware (%)*	Participate (N)	Participate (%)[1]
Baseline	0	221	0	0	0	0
1	0	201	0	0	0	0
2	77	122	6	7.8	0	0
3	117	58	13	11.1	7	6.0
4	201	0	28	13.9	19	9.5
TOTAL	*395*	*602*	*47*		*26*	

* % aware - was the percentage of participants aware of the DAV programme from villages in South Hams that had already received the programme.

[1] % participating - was the percentage of participants who reported participating in DAV events from villages in South Hams that had already received the programme.

Baseline	0	426	0	0	0	0
1	107	267	10	9.3	1	0.9
2	201	189	32	15.9	9	4.5
3	313	71	42	13.4	11	3.5
4	390	0	48	12.3	13	3.3
TOTAL	*1011*	*953*	*132*		*34*	

TEIGNBRIDGE

* % aware - was the percentage of participants aware of the DAV programme from villages in Teignbridge that had already received the programme.
[1] % participating - was the percentage of participants who reported participating in DAV events from villages in Teignbridge that had already received the programme.

TORRIDGE

* % aware - was the percentage of participants aware of the DAV programme from villages in Torridge that had already received the programme.
[1] % participating - was the percentage of participants who reported participating in DAV events

Phase	**Intervention (N)**	**Control (N)**	**Aware of DAV (N)**	**Aware (%)***	**Participate (N)**	**Participate (%)[1]**
Baseline	0	315	0	0	0	0
1	53	219	10	18.9	1	1.9
2	139	151	23	16.5	4	2.9
3	195	81	44	22.6	9	4.6
4	267	0	53	19.9	15	5.6
TOTAL	*654*	*766*	*130*		*29*	

from villages in Torridge that had already received the programme.

WEST DEVON

Phase	**Intervention (N)**	**Control (N)**	**Aware of DAV (N)**	**Aware (%)***	**Participate (N)**	**Participate (%)[1]**
Baseline	0	265	0	0	0	0
1	0	218	0	0	0	0
2	67	115	22	32.8	7	10.4
3	127	59	44	34.6	22	17.3
4	196	0	50	25.5	10	5.1
TOTAL	*390*	*657*	*116*		*39*	

* % aware - was the percentage of participants aware of the DAV programme from villages in West Devon that had already received the programme.

[1] % participating - was the percentage of participants who reported participating in DAV events from villages in West Devon that had already received the programme.

Phase	Intervention (N)	Control (N)	Aware of DAV (N)	Aware (%)*	Participate (N)	Participate (%)[1]
Baseline	0	253	0	0	0	0
1	13	171	4	30.8	1	7.7
2	78	134	15	19.2	5	6.4
3	128	73	15	11.7	1	0.8
4	202	0	31	15.3	11	5.4
TOTAL	*421*	*631*	*65*		*18*	

DEVON (ALL 128 VILLAGES)

* % aware - was the percentage of participants aware of the DAV programme from any villages that had already received the programme.

[1] % participating - was the percentage of participants who reported participating in DAV events from any villages that had already received the programme.

Phase	Intervention (N)	Control (N)	Aware of DAV (N)	Aware (%)*	Participate (N)	Participate (%)[1]
Baseline	0	2413	0	0	0	0
1	322	1658	54	16.8	8	2.5
2	936	1114	163	17.4	37	4.0
3	1417	534	225	15.9	60	4.2
4	2018	0	303	15.0	80	4.0
TOTAL	*4693*	*5719*	*745*		*185*	

Appendix Q. Research summary for Active Devon

Understanding the personal, social, and environmental impact upon physical activity of the 'Devon Active Villages' programme

Research Summary

Researchers:

Miss Emma Solomon	Es244@exeter.ac.uk
Dr Tim Rees	Tim.J.Rees@exeter.ac.uk
Associate Professor Melvyn Hillsdon	M.Hillsdon@exeter.ac.uk
Dr Obioha Ukoumunne	O.C.Ukoumunne@exeter.ac.uk
Dr Brad Metcalf	B.Metcalf@exeter.ac.uk

Background and Aims

Active Devon highlighted a need for research to evaluate the effectiveness of the 'Devon Active Villages' programme. The Centre for Sport, Leisure and Tourism Research at the University of Exeter received funding from the Economic and Social Research Council (ESRC) for 15 PhD CASE Studentships. CASE studentships give students an opportunity to gain experience of work outside academia through collaboration with businesses or organisations on research problems relevant to the partner. After initial discussions between Active Devon, Dr Tim Rees, and Professor Tim Coles, a successful PhD Studentship application for a grant of £57,000 from the ESRC, with an additional £4k per annum contributed by the business partner, was attained. Active Devon was the business partner for this PhD CASE Studentship, and Emma Solomon was appointed as the PhD researcher.

The impact of physical inactivity is not isolated to individuals being at increased risk of various chronic conditions, such as cardiovascular disease, high blood pressure, type 2 diabetes, stroke, obesity, metabolic syndrome, several cancers, and mental health problems. In fact, physical inactivity asserts a considerable economic burden on the National Health Service (circa £0.9 billion per year). In the south-west of England, only 42% of men and 32% of women reported doing sufficient physical activity to meet the recommended activity guidelines in 2008. Government agencies are increasingly attempting to develop effective strategies to increase population levels of physical activity. Community-level physical activity interventions have the potential to produce behaviour changes among large segments of the population. Despite community-level physical activity interventions being routinely delivered using public funds, it is unclear whether such programmes work, as they are rarely or poorly evaluated. More evaluations of community-level physical activity interventions using rigorous study designs are required. Therefore, the aim of the research was to understand the personal, social, and environmental impact upon physical activity of the Devon Active Villages programme.

Literature

In order to change population levels of physical activity, interventions need to be effective, but they also need to reach large numbers of people. Fortunately, substantial health benefits can be achieved through relatively modest changes in activity behaviour among large segments of the population. It is community-level interventions, therefore, that have the potential to produce long-lasting benefits for the whole community. Evaluations of community-level interventions can pose a considerable challenge, partly due to the complex, multi-leveled nature of the intervention, which makes any straightforward link between input and output extremely difficult to establish. To meet the growing demand for accountability, funding agencies increasingly require large-scale evaluations of the impact of community-level physical activity interventions.

To date, evaluations of community-level physical activity interventions have tended to focus on whether the programme being studied results in behaviour change, but only for the individuals that participated in programme events. This approach tells us whether an intervention is effective at the individual-level, but cannot tell us whether there has been any intervention effect in the wider community. Therefore, evaluations should focus on what effect interventions have on physical activity levels at the community-level.

There are many study designs to choose from when evaluating community-level interventions, with different designs suiting different research questions and different circumstances. The Devon Active Villages programme was by necessity delivered in phases, with multiple village communities receiving the programme at each phase. Also, once the initial twelve-week intervention phase ended, the village communities were encouraged to independently sustain the programme activities, and so the programme was effectively never withdrawn. These programme characteristics fit nicely with the requirements for a *stepped wedge cluster randomised trial design*, in which interventions are delivered sequentially to all communities over a number of time periods. Communities effectively cross over from the control to the intervention group, and the stage at which the communities cross over is randomly allocated. Outcomes are measured on the study participants in all communities at every time period, so that each community provides data points in both the control and intervention conditions. Advantages of the stepped wedge cluster randomised trial design are that all communities will eventually receive the programme, that it can be delivered in phases, and that once delivered it is not withdrawn (as would occur in a cross-over design). On this basis, the stepped wedge cluster randomised trial design was selected as a robust method for evaluating the effectiveness of the Devon Active Villages intervention. To date, no other studies have used the stepped wedge trial design to evaluate a community-level physical activity intervention, making this research study unique.

Methods

Active Devon identified 155 rural villages to receive the Devon Active Villages intervention across the course of three years. Prior to the intervention, Active Devon ran a pilot intervention with 15 villages, the outcome of which was used to inform the main intervention protocol. Of the remaining 140 villages that were not part of the pilot, twelve could not be included in the evaluation due to engagement with local community members before baseline data collection had commenced. Thus, the remaining 128 villages were recruited and randomised to first receive the intervention in one of the four phases, stratified by the seven regions of the county of Devon. The intervention was fully implemented by the end of the trial, with all 128 villages receiving the intervention: 22 first receiving the intervention at phase 1, 36 at phase 2, 35 at phase 3, and 35 at phase 4.

The evaluation consisted of data collection, in the form of a postal survey study, at five fixed time points (baseline and following each of the four intervention phases, Figure 1). Data collection time points were March 2011, July 2011, January 2012, July 2012, and January 2013. The study used a repeated cross-sectional design, in which a random sample of adults (aged 18 years and over) within each village was surveyed at each time point. A complete list of all households in each of the 128 study villages was obtained using the Postcode Address File. The order in which households were approached to participate in the survey at each time point was randomly generated, with one adult per household randomly selected.

The primary outcome of interest was physical activity behaviour, in terms of both the total number of minutes spent in moderate-and-vigorous activity per week, and the proportion of adults that reported sufficient physical activity to meet the current guidelines (i.e., 150 minutes of moderate-intensity physical activity per week or 75 minutes of vigorous-intensity physical activity per week). Secondary outcomes included physical activity habits and intentions, the perceived availability and use of recreational facilities in the village, and awareness and participation in the Devon Active Villages programme.

Based on power calculations, it was estimated that 10 participants would need to complete the survey from each of the 128 villages at each time point. To achieve an anticipated 20% response rate, 6,400 surveys were sent out at every time point (50 surveys to each village), with the expectation that at least 1,280 would be completed and returned. We received assistance with the statistical data analysis from the University of Exeter Medical School (Dr Obioha Ukoumunne).

Of the 32,315 surveys that were sent out, 10,412 were completed and returned (response rate 32.2%, range 30.3% at time point four to 37.7% at time point one). Of these, 38.8% were male, and the mean age was 58 years. Compared to the general population of the 128 intervention villages, the study participants tended to be older (71.9% versus 59.2%, aged 50 years or over), and a greater proportion were female (61.2% versus 51%). 4,693 participants provided data in the intervention group, and 5,719 in the control group. Intervention participants were classified as all survey respondents from the villages that had received the Devon Active Villages programme in the current or previous time periods.

For more detail on the study protocol, please see the paper:
Solomon, Rees, Ukoumunne, & Hillsdon. (2012). The Devon Active Villages Evaluation (DAVE) trial: Study protocol of a stepped wedge cluster randomised trial of a community-level physical activity intervention in rural southwest England. BMC Public Health, 12: 581.
Found at: www.biomedcentral.com/1471-2458/12/581.

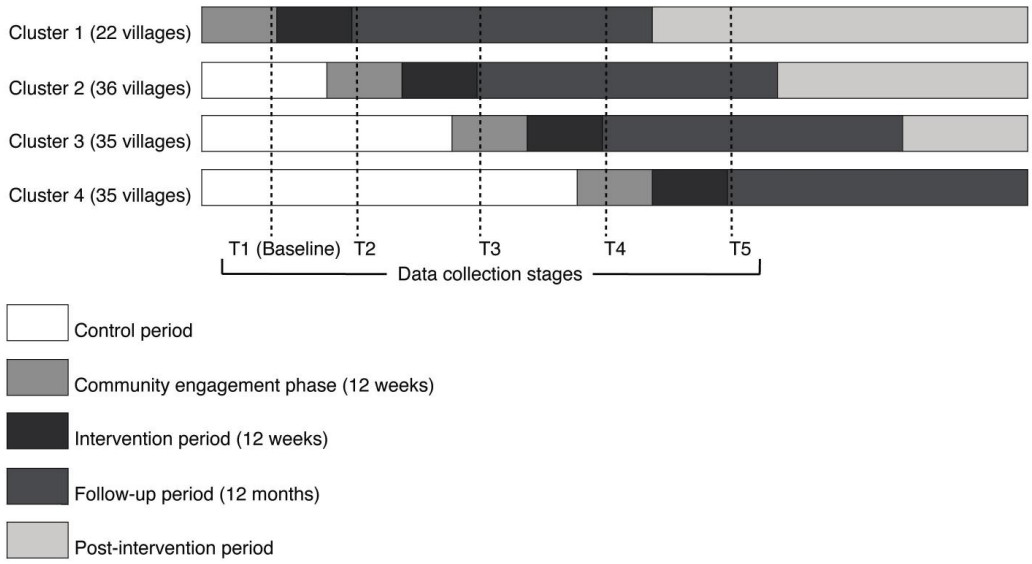


Figure 1 Data collection timeline for the Devon Active Villages Evaluation study.

Main Findings

1. Physical activity

- Compared to the controls, the intervention group (respondents from the villages that had already received the DAV programme) reported doing more minutes of moderate- to vigorous-intensity physical activity per week. Statistically, however, this result was non-significant.
    - More specifically, the intervention group reported doing an additional 40 minutes of moderate-intensity physical activity per week (on average), compared to the control group.
- Despite the above results, there was little evidence to suggest the intervention was associated with a greater likelihood of meeting the government recommended physical activity guidelines.
- There were no differences in physical activity between the seven regions of Devon.

2. Correlates

- A significantly greater percentage of the intervention participants had favourable physical activity habits, compared to control participants (51.5% versus 47.5%).
- There were no differences between intervention and control participants for physical activity social norms, perceived village supportiveness for physical activity, intentions or commitment to doing more physical activity, awareness of local walking routes/footpaths, local parks/public green space, indoor sports facilities, or a local community centre/village hall, or use and locality of recreational facilities.

3. Awareness/ participation/ opinions of the programme

- 16% of intervention participants reported being aware of the Devon Active Villages programme.
- 4% of intervention participants reported participating in Devon Active Villages programme events.
- Of the participants who reported being aware of the programme, 50.6% agreed it was a good campaign, 29.8% found the programme interesting, and 21.5% reported that the intervention made them think about physical activity or exercise.
- In total, 80% of the reported opinions on the Devon Active Villages programme were positive.

4. Intervention registrations

Interpretation of the intervention registrations collected by the Local Delivery Partners, on behalf of Active Devon. Registration figures correct to July 2013.

- In the intervention villages, 5.2% of the population registered as participants in programme events, although when children (aged 16 years and under) were excluded, this figure was reduced to 2.7% of the adult population of the villages.
- Greatest participation in programme events occurred in the villages that received the intervention in phase 2 (4.3% of the adult population).
- Several villages had no registrations for programme events, while others achieved up to 48% population penetration (adults and children).

Table 1 Mean proportion of adult registrations for the different regions

Region	Adult registrations (%)
East Devon	3.42
Mid Devon	1.09
North Devon	4.74
South Hams	1.56
Teignbridge	4.66
Torridge	7.23
West Devon	4.45

5. Implications

- Implementation of the Devon Active Villages programme did result in marginal increases in the physical activity behaviour of adults.
- Positive improvements in physical activity habits were reported in response to the Devon Active Villages programme.
- Opinions of the Devon Active Villages programme were favourable.
- Reported awareness and participation in the Devon Active Villages programme was low among the intervention group.
- The proportion of adults in each of the villages that registered to participate in programme events was low.
- With greater investment into community outreach/engagement, in order to reach a substantial proportion of the intervention communities, it is highly likely that the Devon Active Villages programme would have been able to significantly change physical activity behaviour at the community-level.
- The stepped wedge cluster randomised trial design was a suitable design for evaluating the Devon Active Villages programme.

6. Recommendations

- Future community-level physical activity interventions should consider incorporating the structure and design of the Devon Active Villages programme, with greater investment into community outreach/ engagement activities.
- More research is needed into how to cost-effectively achieve greater community outreach/engagement during community-level physical activity interventions.
- More research is needed into understanding the physical activity behaviour of adults from rural settings, and how to effectively tailor interventions to this understudied population.
- More rigorous evaluations of community-level physical activity interventions are needed to aid the understanding of what works in changing population levels of physical activity.
- Future evaluation studies should consider the use of the stepped wedge cluster randomised trial design for evaluating community-level physical activity interventions.

BIBLIOGRAPHY

General references

Ainsworth, B.E., Haskell, W.L., Whitt, M.C., Irwin, M.C., & Swartz, A.M. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise, 32*(Suppl. 9), 498-504.

Allender, S., Foster, C., Scarborough, P., & Rayner, M. (2007). The burden of physical activity-related ill health in the UK. *Journal of Epidemiology and Community Health, 61*, 344-348.

Allender, S., Hutchinson, L., & Foster, C. (2008). Life-change events and participation in physical activity: a systematic review. *Health Promotion International, 23*, 160-172.

Altman, D.G., Schulz, K.F., Moher, D., Egger, M., Davidoff, F., Elbourne, D., Gotzsche, P.C., Lang, T., & CONSORT GROUP (Consolidated Standards of Reporting Trials). (2001). The revised CONSORT statement for reporting randomized trials: explanation and elaboration. *Annals of Internal Medicine, 134,* 663-694.

Arthur, M., & Piatt, W. (2012). The social impact of research conducted in Russell Group universities. Russell Group Papers – Issue 3, 2012.

Avons, P., Garthwaite, P., Davies, H.L., Murgatroyd, P.R., & James, W.P. (1988). Approaches to estimating physical activity in the community: calorimetric validation of actometers and heart rate monitoring. *European Journal of Clinical Nutrition, 42*, 185-196.

Baker, P.R.A., Francis, D.P., Soares, J., Weightman, A.L., & Foster, C. (2011). Community wide interventions for increasing physical activity. *Cochrane Database of Systematic Reviews 2011,* (Issue 4).

Bandura, A. (1986). Social foundations of thought and action: a social cognitive theory. Prentice Hall, Englewood Cliffs, NJ.

Bandura, A. (1997). Self-efficacy and the exercise of control. WH Freeman, New York, NY.

Baranowski, T., & de Moor, C. (2000). How many days was that? Intra-individual variability and physical activity assessment. *Research Quarterly for Exercise and Sport, 71*, 74-78.

Barnidge, E.K., Radvanyi, C., Duggan, C., Motton, F., Wiggs, I., Baker, E.A., & Brownson, R.C. (2013). Understanding and Addressing Barriers to Implementation of Environmental and Policy Interventions to Support Physical Activity and Healthy Eating in Rural Communities. *The Journal of Rural Health,*

29, 97-105.

Bassett, D., Mahar, M., Rowe, D., & Morrow, J. (2008). Walking and measurement. *Medicine and Science in Sports and Exercise, 40*(Suppl. 7), 529-536.

Bauman, A., Reis, R.S., Sallis, J.F., Wells, J.C., Loos, R.J.F., Martin, B.W., for the Lancet Physical Activity Series Working Group. (2012). Correlates of physical activity: why are some people physically active and others not? *The Lancet*, *380,* 258-271.

Bauman, A.E., Sallis, J.F., Dzewaltowski, D.A., & Owen, N. (2002). Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders. *American Journal of Preventive Medicine, 23*(Suppl. 2)**,** 5-14.

Bélanger, M., Townsend, N., & Foster, C. (2011). Age-related differences in physical activity profiles of English adults. *Preventive Medicine, 52*, 247-249.

Bellamy, G.R., Bolin, J.N., & Gamm, L.D. (2011). Rural healthy people 2010, 2020, and beyond: the need goes on. *Family & Community Health*, *34*(2), 182-188.

Bergman, P., Grjibovski, A.M., Hagströmer, M., Bauman, A., & Sjöström, M. (2008). Adherence to physical activity recommendations and the influence of socio-demographic correlates - a population-based cross-sectional study. *BMC Public Health, 8*, 367.

Bertrais, S., Preziosi, P., Mennen, L., Galan, P., Hercberg, S., & Oppert, J-M. (2004). Sociodemographic and geographic correlates of meeting current recommendations for physical activity in middle-age French adults: the Supplementation en Vitamines et Mineraux Antioxydants (SUVIMAX) Study. *American Journal of Public Health*, *94*(9), 1560-1566.

Bland, J.M. (2000). Sample size in guidelines trials. *Family Practice, 17*(Suppl. 1), 17-20.

Bock, C., Jarczok, M.N., & Litaker, D. (2013). Community-based efforts to promote physical activity: A systematic review of interventions considering mode of delivery, study quality and population subgroups. *Journal of Science and Medicine in Sport,* [In press].

Bopp, M., & Fallon, E. (2008). Community-based interventions to promote increased physical activity: a primer. *Applied Health Economics and Health Policy, 6*, 173-187.

Brage, S., Brage, N., Franks, P.W., Ekelund, U., & Wareham, N.J. (2005). Reliability and validity of the combined heart rate and movement sensor Actiheart. *European Journal of Clinical Nutrition, 59*, 561-570.

Brage, S., Brage, N., Franks, P.W., Ekelund, U., Wong, M.Y., Andersen, L.B., Froberg, K., & Wareham, N.J. (2004). Branched equation modeling of

simultaneous accelerometry and heart rate monitoring improves estimate of directly measured physical activity energy expenditure. *Journal of Applied Physiology, 96*, 343-351.

Brage, S., Wedderkopp, N., Franks, P.W., Andersen, L.B., & Froberg, K. (2003). Reexamination of validity and reliability of the CSA monitor in walking and running. *Medicine and Science in Sports and Exercise, 35*, 1447-1454.

Bravata, D.M., Smith-Spangler, C., Sundaram, V., Gienger, A.L., Lin, N., Lewis, R., Stave, C.D., Olkin, I., & Sirard, J.R. (2007). Using pedometers to increase physical activity and improve health: a systematic review. *Journal of the American Medical Association, 298*, 2296-2304.

Brown, C.A., & Lilford, R.J. (2006). The stepped wedge trial design: a systematic review. *BMC Medical Research Methodology, 6*, 54.

Brown, W.J., Mummery, K., Eakin, E., & Schofield, G. (2006). 10,000 Steps Rockhampton: Evaluation of a whole community approach to improving population levels of physical activity. *Journal of Physical Activity and Health, 1*, 1-14.

Brownson, R.C., Baker, E.A., Boyd, R.L., Caito, N.M., Duggan, K., Housemann, R.A., Kreuter, M.W., Mitchell, T., Motton, F., Pulley, C., Schmid, T.L., & Walton, D. (2004). A community-based approach to promoting walking in rural areas. *American Journal of Preventive Medicine, 27*(1), 28-34.

Brownson, R.C., Baker, E.A., Housemann, R.A., Brennan, L.K., & Bacak, S.J. (2001). Environmental and policy determinants of physical activity in the United States. *American Journal of Public Health, 91*(12), 1995-2003.

Brownson, R.C., Eyler, A.A., King, A.C., Brown, D.R., Shyu, Y.L., & Sallis, J.F. (2000a). Patterns and correlates of physical activity among US women 40 years and older. *American Journal of Public Health*, *90*(2), 264-270.

Brownson, R.C., Hagood, L., Lovegreen, S.L., Britton, B., Caito, N.M., Elliott, M.B., Emery, J., Haire-Joshu, D., Hicks, D., Johnson, B., McGill, J.B., Morton, S., Rhodes, G., Thurman, T., & Tune, D. (2005). A multilevel ecological approach to promoting walking in rural communities. *Preventive Medicine, 41*(5-6), 837-842.

Brownson, R.C., Housemann, R.A., Brown, D.R., Jackson-Thompson, J., King, A.C., Malone, B.R., & Sallis, J.F. (2000b). Promoting physical activity in rural communities: walking trail access, use, and effects. *American Journal of Preventive Medicine*, *18*(3), 235–241.

Burton, N.W., Oldenburg, B., Sallis, J.F., & Turrell, G. (2007). Measuring psychological, social, and environmental influences on leisure-time physical activity among adults. *Australia New Zealand Journal of Public Health*, *31,* 36-43.

Caplan, L.S., Lane, D.S., & Grimson, R. (1995). The Use of Cohort vs Repeated Cross-Sectional Sample Survey Data in Monitoring Changing Breast Cancer Screening Practices. *Preventive Medicine, 24,* 553-556.

Caspersen, C.J., Powell, K.E., & Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126-131.

Cauley, J.A., LaPorte, R.E., Sandler, R.B., Schramm, M.M., & Kriska, A.M. (1987). Comparison of methods to measure physical activity in postmenopausal women. *American Journal of Clinical Nutrition, 45*, 14-22.

Cavill, N., Richardson, D., & Foster, C. (2012). Improving Health Through Participation in Sport: a review of research and practice. British Heart Foundation Health Promotion Research Group. University of Oxford.

Chen, K., & Bassett, D.R. (2005). The technology of accelerometer-based activity monitors: Current and future. *Medicine and Science in Sports and Exercise, 37*, S490-500.

Cleland, V., Ball, K., Hume, C., Timperio, A., King, A.C., & Crawford, D. (2010). Individual, social and environmental correlates of physical activity among women living in socioeconomically disadvantaged neighbourhoods. *Social Science & Medicine, 70*(12), 2011-2018.

Cleland, V.J., Schmidt, M.D., Salmon, J., Dwyer, T., & Venn, A. (2011). Correlates of pedometer-measured and self-reported physical activity among young Australian adults. *Journal of Science and Medicine in Sport, 14*(6), 496-503.

Cook, T.D., & Campbell, D. (1979). Quasi-experimentation: Design and analysis issues for field settings. Boston: Houghton Mifflin.

Crabtree, B.F., Ray, S.C., Schmidt, P.M., O'Connor, P.J., & Schmidt, D.D. (1990). The individual over time: time series applications in health care research. *Journal of Clinical Epidemiology, 43,* 241-260.

Craig, P., Dieppe, P., Macintyre, S.J., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: new guidance. Medical Research Council.

Craig, C.L., Marshall, A.L., Sjostrom, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity**.** *Medicine and Science in Sports and Exercise*, *35,* 1381-1395.

Craig, R., Mindell, J., & Hirani, V. (2009). Health Survey for England 2008, Volume 1: Physical activity and fitness. London: National Centre for Social Research.

Cutt, H., Giles-Corti, B., Knuiman, M., & Burke, V. (2007). Dog ownership, health and physical activity: A critical review of the literature. *Health Place*, *13*,

261-272.

Cutt, H., Giles-Corti, B., Knuiman, M., Timperio, A., & Bull, F. (2008). Understanding Dog Owners' Increased Levels of Physical Activity: Results From RESIDE. *American Journal of Public Health, 98*(1), 66-69.

De Bourdeaudhuij, I., Teixeira, P.J., Cardon, G., & Deforche, B. (2005). Environmental and psychosocial correlates of physical activity in Portuguese and Belgian adults. *Public Health Nutrition, 8*(7), 886-895.

De Cocker, K.A., De Bourdeaudhuij, I.M., Brown, W.J., & Cardon, G.M. (2007). Effects of "10,000 steps Ghent": a whole-community intervention. *American Journal of Preventive Medicine, 33*(6), 455-463.

De Cocker, K.A., De Bourdeaudhuij, I.M., Brown, W.J., & Cardon, G.M. (2011). Four-year follow-up of the community intervention '10,000 steps Ghent'. *Health Education Research, 26*(2), 372-380.

Delgado-Rodriguez, M., & Llorca, J. (2004). Bias. *Journal of Epidemiology and Community Health, 58*, 635-641.

Department for Communities and Local Government. (2011). English indices of deprivation 2010: Statistics on relative levels of deprivation in England. London: Department for Communities and Local Government.

Department of Health. (2010). Health Profile 2010: Devon. Department of Health. Retrieved from http://www.healthprofiles.info.

Department of Health, Physical Activity, Health Improvement and Protection. (2011). Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. London: Department of Health.

Doherty, A.R., Kelly, P., Kerr, J., Marshall, S., Oliver, M., Badland, H., & Foster, C. (2012). Use of wearable cameras to assess population physical activity behaviours: an observational study. *The Lancet, 380*, S35.

Dowda, M., Ainsworth, B.E., Addy, C.L., Saunders, R., & Riner, W. (2003). Correlates of physical activity among U.S. young adults, 18 to 30 years of age, from NHANES III. *Annals of Behavioral Medicine, 26*(1), 15-23.

Dugas, L.R., Van der Merwe, L., Odendaal, H., Noakes, T.D., & Lambert, E.V. (2005). A novel energy expenditure prediction equation for intermittent physical activity. *Medicine and Science in Sports and Exercise, 37*, 2154-2161.

Dumbrowski, S.U., Sniehotta, F.F., Avenell, A.A., & Coyne, J.C. (2007). Towards a cumulative science of behaviour change: do current conduct and reporting of behavioural interventions fall short of best practice? *Psychology and Health, 22*(8), 869-874.

Duru, O.K., Sarkisian, C.A., Leng, M., & Mangione, C.M. (2010). Sisters in motion: a randomized controlled trial of a faith-based physical activity intervention. *Journal of the American Geriatrics Society*, *58*, 1863-1869.

Eaton, C.B., Lapane, K.L., Garber, C.E., Gans, K.M., Lasater, T.M., & Carleton, R.A. (1999). Effects of a community-based intervention on physical activity: the Pawtucket Heart Health Program. *American Journal of Public Health, 89*(11), 1741-1744.

Eccles, M., Grimshaw, J., Campbell, M., & Ramsay, C. (2003). Research designs for studies evaluating the effectiveness of change and improvement strategies. *Quality and Safety in Healthcare, 12,* 47-52.

Edwards, P., Roberts, I., Clarke, M., DiGuiseppi, C., Pratap, S., Wentz, R., & Kwan, I. (2002). Increasing response rates to postal questionnaires: systematic review. *British Medical Journal, 324,* 1183-1185.

Ekelund, U. (2004). Methods to Measure Physical Activity Symposium. MRC Epidemiology Unit, Cambridge. Retrieved from: www.dasfas.dk/2004/Ulf_Ekelund_Symposium_300804.pdf.

Ekelund, U., Sepp, H., Brage, S., Becker, W., Jakes, R., Hennings, M., & Wareham, N.J. (2006). Criterion-related validity of the last 7-day, short form of the International Physical Activity Questionnaire in Swedish adults. *Public Health Nutrition, 9*(2), 258-265.

Eldridge, S., Ashby, D., Bennett, C., Wakelin, M., & Feder, G. (2008). Internal and external validity of cluster randomised trials: systematic review of recent trials. *British Medical Journal, 336*, 876.

Eyler, A.A. (2003). Personal, social, and environmental correlates of physical activity in rural Midwestern white women. *American Journal of Preventive Medicine*, *25*(3 Suppl 1), 86-92.

Eyler, A.A., Matson-Koffman, D., Evenson, K., Sanderson, B., Thomson, J., Wilbur, J., & Rohm-Young, D. (2000). Environmental, policy, and cultural barriers to physical activity in a diverse sample of women: The Women's Cardiovascular Health Network Project – Summary and Discussion. *Women & Health*, *36*(2), 123-134.

Eyler, A.A., Matson-Koffman, D., Young, D.R., Wilcox, S., Wilbur, J., Thompson, J.L., Sanderson, B., & Evenson, K.R. (2003). Quantitative study of correlates of physical activity in women from diverse racial/ethnic groups: The Women's Cardiovascular Health Network Project--summary and conclusions. *American Journal of Preventive Medicine, 25*(3 Suppl. 1), 93-103.

Faridi, Z., Shuval, K., Njike, V.Y., Katz, J.A., Jennings, G., Williams, M., Katz, D.L., & PREDICT Project Working Group. (2010). Partners reducing effects of diabetes (PREDICT): a diabetes prevention physical activity and dietary intervention through African-American churches. *Health Education Research, 25*(2), 306-315.

Foster, C., Hillsdon, M., Jones, A., Grundy, C., Wilkinson, P., White, M., Sheehan, B., Wareham, N., & Thorogood, M. (2009). Objective Measures of the Environment and Physical Activity—Results of the Environment and Physical

Activity Study in English Adults. *Journal of Physical Activity and Health, 6*(Suppl 1), S70-S80.

Foster, C., Hillsdon, M., & Thorogood, M. (2005). Interventions for promoting physical activity (Review). *Cochrane Database of Systematic Reviews 2005*, (Issue 1).

Frost, S.S., Turner Goins, R., Hunter, R.H., Hooker, S.P., Bryant, L.L., Kruger, J., & Pluto, D. (2010). Effects of the Built Environment on Physical Activity of Adults Living in Rural Settings. *American Journal of Health Promotion, 24*(4), 267-283.

Gambia Hepatitis Study Group. (1987). The Gambia Hepatitis Intervention Study. *Cancer Research, 47,* 5782-5787.

Garrett, S., Elley, C.R., Rose, S.B., O'Dea, D., Lawton, B.A., & Dowell, A.C., (2011). Are physical activity interventions in primary care and the community cost-effective? A systematic review of the evidence. *British Journal of General Practice*, *61*(584), 125-133.

Garrett, N., Schluter, P.J., & Schofield, G. (2012). Physical activity profiles and perceived environmental determinants in New Zealand: a national cross-sectional study. *Journal of Physical Activity and Health, 9*(3), 367-377.

Gebel, K., Bauman, A.E., Reger-Nash, B., & Leyden, K.M. (2011). Does the environment moderate the impact of a mass media campaign to promote walking? *American Journal of Health Promotion, 26*(1), 45-48.

Giles-Corti, B., & Donovan, R.J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine, 54*(12), 1793-1812.

Goodman, E., & Strauss, R.S. (2003). Self-reported height and weight and the definition of obesity in epidemiologic studies. *Journal of Adolescent Health, 33*, 140-141.

Grant, A.D., Charalambous, S., Fielding, K.L., Day, J.H., Corbett, E.L., Chaisson, R.E., De Cock, K.M., Hayes, R.J., & Churchyard, G.J. (2005). Effect of routine Isoniazid preventative therapy on Tuberculosis incidence among HIV-infected men in South Africa. *Journal of the American Medical Association, 22,* 2719-2725.

Grimshaw, J., Campbell, M., Eccles, M., & Steen, N. (2000). Experimental and quasi-experimental designs for evaluating guideline implementation strategies. *Family Practice, 17,* S11-S18.

Gulliford, M.C., Ukoumunne, O.C., & Chinn, S. (1999). Components of variance and intraclass correlations for the design of community-based surveys and intervention studies. *American Journal of Epidemiology, 149,* 876-883.

Habicht, J.P., Victora, C.G., & Vaughan, J.P. (1999). Evaluation designs for adequacy, plausibility and probability of public health programme performance

and impact. *International Epidemiological Association, 28*, 10-18.

Hanley, J.A., Negassa, A., Edwardes, M.D., & Forrester, J.E. (2003). Statistical Analysis of Correlated Data Using Generalized Estimating Equations: An Orientation. *American Journal of Epidemiology, 157*(4), 364-375.

Hansen, B.H., Ommundsen, Y., Holme, I., Kolle, E., & Anderssen, S.A. (2013). Correlates of objectively measured physical activity in adults and older people: a cross-sectional study of population-based sample of adults and older people living in Norway. *International Journal of Public Health*, Apr 26 [Epub ahead of print].

Harding, A.H., Griffin, S.J., & Wareham, N.J. (2006). Population impact of strategies for identifying groups at high risk of type 2 diabetes. *Preventive Medicine*, *42*, 364-368.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., & Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*, *116*, 1081–1093.

Haskell, W.L., Yee, M.C., Evans, A., & Irby, P.J. (1993). Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Medicine and Science in Sports and Exercise, 25*, 109-115.

Helmerhorst, H.J., Brage, S., Warren, J., Besson, H., & Ekelund, U. (2012). A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. *International Journal of Behavioral Nutrition and Physical Activity*, *9,* 103.

Hills, D. (2004). Evaluation of community-level interventions for health improvement: a review of experience in the UK. London: NHS, Health Development Agency.

Hodkinson, P., & Hodkinson, H. (2001). The Strengths and Limitations of Case Study Research. Paper presented to the Learning and Skills Development Agency conference: Making an Impact on Policy and Practice, Cambridge: 5-7 December 2001.

Hoehner, C.M., Brennan Ramirez, L.K., Elliott, M.B., Handy, S.L., & Brownson, R.C. (2005). Perceived and objective environmental measures and physical activity among urban adults. *American Journal of Preventive Medicine, 28*, 105-116.

House of Lords. (2011). Science and Technology Select Committee: Behaviour Change. London: Authority of the House of Lords.

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults participation in physical activity: a review. *American Journal of Preventive Medicine*, *22*, 58-69.

Hussey, M.A., & Hughes, J.P. (2007). Design and analysis of stepped wedge cluster randomized trials. *Contemporary Clinical Trials, 28,* 182-191.

Inoue, S., Ohya, Y., Odagiri, Y., Takamiya, T., Suijo, K., Kamada, M., Okada, S., Tudor-Locke, C., & Shimomitsu, T. (2011). Sociodemographic determinants of pedometer-determined physical activity among Japanese adults. *American Journal of Preventive Medicine, 40*(5), 566-571.

Institute for Work & Health. (2001). Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries: How to show whether a safety intervention really works. Centers for Disease Control and Prevention, 17-28.

International Physical Activity Questionnaire. (2005). Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ): Short and Long Forms. Retrieved from http://www.ipaq.ki.se.

Irwin, M.L., Ainsworth, B.E., & Conway, J.M. (2001). Estimation of energy expenditure from physical activity measures: determinants of accuracy. *Obesity Reviews, 9,* 517-525.

Jackson, C., Altman, D., Howard-Pitney, B., & Farquhar, J.W (1989). Evaluating community level health promotion and disease prevention interventions. In: Braverman, M. (Ed.) Evaluating Health Promotion Programs. New Directions for Program Evaluation No. 45. San Francisco: Jossey-Bass. 1989.

Jackson, J.E., Doescher, M.P., Jerant, A.F., & Hart, L.G. (2005). A national study of obesity prevalence and trends by type of rural county. *Journal of Rural Health, 21*(2), 140-148.

Janssen, I., Dugan, S.A., Karavolos, K., Lynch, E.B., & Powell, L.H. (2013). Correlates of 15-Year Maintenance of Physical Activity in Middle-Aged Women. *International Journal of Behavioral Medicine, Jun 29* [Epub ahead of print].

Jenum, A.K., Anderssen, S.A., Birkeland, K.I., Holme, I., Graff-Iversen, S., Lorentzen, C., Ommundsen, Y., Raastad, T., Odegaard, A.K., & Bahr, R. (2006). Promoting physical activity in a low-income multiethnic district: effects of a community intervention study to reduce risk factors for type 2 diabetes and cardiovascular disease: a community intervention reducing inactivity. *Diabetes Care, 29*(7), 1605-1612.

Jenum, A.K., Lorentzen, C.A., & Ommundsen, Y. (2009). Targeting physical activity in a low socioeconomic status population: observations from the Norwegian 'Romsas in Motion' study. *British Journal of Sports Medicine, 43*(1), 64-69.

Jiang, B., Wang, W., & Wu, S. (2008). The effects of community intervention measures on prevention and control of hypertension. *Chinese Journal of Prevention and Control of Chronic Non-communicable Disease, 16*(6), 254–257.

Kaewthummanukul, T., & Brown, K.C. (2006). Determinants of employee participation in physical activity: critical review of the literature. *AAOHN Journal, 54*, 249.

Kahn, E.B., Ramsey, L.T., Brownson, R.C., Heath, G.W., Howze, E.H., Powell, K.E., Stone, E.J., Rajab, M.W., & Corso, P. (2002). The effectiveness of interventions to increase physical activity - A systematic review. *American Journal of Preventive Medicine, 22*(4), 73-108.

Kamada, M., Kitayuguchi, J., Inoue, S., Ishikawa, Y., Nishiuchi, H., Okada, S., Harada, K., Kamioka, H., & Shiwaku, K. (2013). A community-wide campaign to promote physical activity in middle-aged and elderly people: a cluster randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 44.

Kaplan, M.S., Newsom, J.T., McFarland, B.H., & Lu, L. (2001). Demographic and psychosocial correlates of physical activity in late life. *American Journal of Preventive Medicine, 21*(4), 306-312.

Khan, L.K., Sobush, K., Keener, D., Goodman, K., Lowry, A., Kakietek, J., Zaro, S., Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion CDC, CDC Foundation, ICF Macro. (2009). Recommended Community Strategies and Measurements to Prevent Obesity in the United States. *MMWR Recommendations and Reports, 58*, 1-26.

Kim, H.K., Kim, M.J., Park, C.G., & Kim, H.O. (2010). Gender differences in physical activity and its determinants in rural adults in Korea. *Journal of Clinical Nursing, 19*(5-6), 876-883.

Kim, K.H., Linnan, L., Campbell, M.K., Brooks, C., Koenig, H.G., & Wiesen, C. (2008). The WORD (Wholeness, Oneness, Righteousness, Deliverance): a faith-based weight-loss program utilizing a community-based participatory research approach. *Health Education & Behavior, 35*, 634-650.

King, L., Gill, T., Allender, S., & Swinburn, B. (2011). Best practice principles for community-based obesity prevention: development, content and application. *Obesity Reviews, 12*, 329-338.

Kirk, R.E. (2012). Experimental Design: Procedures for the Behavioral Sciences (4th Edition). Thousand Oaks, CA: Sage Publications, 30-76.

Kirk, M.A., & Rhodes, R.E. (2011). Occupation Correlates of Adults' Participation in Leisure-Time Physical Activity: A Systematic Review. *American Journal of Preventive Medicine, 40*(4), 476-485.

Kloek, G.C., van Lenthe, F.J., van Nierop, P.W., Koelen, M.A., & Mackenbach, J.P. (2006). Impact evaluation of a Dutch community intervention to improve health-related behaviour in deprived neighbourhoods. *Health Place, 12*(4), 665-677.

Kohl, H.W., Craig, C.L., Lambert, E.V., Inoue, S., Alkandari, J.R., Leetongin, G., Kahlmeier, S., for the Lancet Physical Activity Series Working Group. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet, 380*(9838), 294-305.

Lee, P.H., Macfarlane, D.J., Lam, T.H., & Stewart, S.M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 8*, 115.

Lee, R.E., O'Connor, D.P., Smith-Ray, R., Mama, S.K., Medina, A.V., Reese-Smith, J.Y., Banda, J.A., Layne, C.S., Brosnan, M., Cubbin, C., McMillan, T., & Estabrooks, P.A. (2012b). Mediating effects of group cohesion on physical activity and diet in women of color: health is power. *American Journal of Health Promotion, 26*(4), 116-125.

Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., & Katzmarzyk, P.T. (2012a). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet*, *380*(9838), 219-229.

Li, R., Deurenberg, P., & Hautvast, J.G. (1993). A critical evaluation of heart rate monitoring to assess energy expenditure in individuals. *American Journal of Clinical Nutrition, 58*, 602-607.

Lifson, N., Gordon, G.B., & McClintock, R. (1955). Measurement of total carbon dioxide production by means of $D_2\ ^{18}O$. *Journal of Applied Physiology, 7*, 704-710.

Lupton, B.S., Fønnebø, V., & Søgaard, A.J. (2003). The Finnmark Intervention Study: is it possible to change CVD risk factors by community-based intervention in an Arctic village in crisis? *Scandinavian Journal of Public Health, 31*(3), 178-186.

Macera, C.A., Jackson, K.L., Davis, D.R., Kronenfeld, J.J., & Blair, S.N. (1990). Patterns of non-response to a mail survey. *Journal of Clinical Epidemiology, 43*(12), 1427-1430.

Macfarlane, D.J., Lee, C.C., Ho, E.Y., Chan, K.L., & Chan, D. (2006). Convergent validity of six methods to assess physical activity in daily life. *Journal of Applied Physiology, 101,* 1328-1334.

Maddison, R., & Ni Mhurchu, C. (2009). Global positioning system: a new opportunity in physical activity measurement. *International Journal of Behavioral Nutrition and Physical Activity, 6*, 73.

Martin, S.L., Kirkner, G.J., Mayo, K., Matthews, C.E., Durstine, J.L., & Hebert, J.R. (2005). Urban, rural, and regional variations in physical activity. *Journal of Rural Health*, *21,* 239-244.

Matthews, C.E. (2002). Use of self report instruments to assess physical activity. In: Welk, G.J. (Ed.) Physical activity assessments for health-related research. Champaign, IL: Human Kinetics.

McCormack, G.R., Giles-Corti, B., Bulsara, M., & Pikora, T.J. (2006). Correlates of distances traveled to use recreational facilities for physical activity behaviors. *International Journal of Behavioral Nutrition and Physical Activity, 3*, 18.

McKee, M., Britton, A., Black, N., McPherson, K., Sanderson, C., & Bain, C. (1999). Interpreting the evidence: choosing between randomised and non-randomised studies. *British Medical Journal*, *319,* 312-315.

Merzel, C., & D'Afflitti, J. (2003). Reconsidering community-based health promotion: promise, performance, and potential. *American Journal of Public Health*, *93*, 557-574.

Miller, W.R., & Johnson, W.R. (2008). A natural language screening measure for motivation to change. *Addictive Behaviors*, *33,* 1177-1182.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med, 6*(7).

Mummery, W.K., & Brown, W.J. (2009). Whole of community physical activity interventions: easier said than done. *British Journal of Sports Medicine, 43*(1), 39-43.

Murimi, M.W., & Harpel, T. (2010). Practicing preventive health: the underlying culture among low-income rural populations. *Journal of Rural Health*, *26*(3), 273-282.

Murphy, M.H., Donnelly, P., Shibli, S., Foster, C., & Nevill, A.M. (2012). Physical activity, walking and leanness: An analysis of the Northern Ireland Sport and Physical Activity Survey (SAPAS). *Preventive Medicine, 54*, 140-144.

Mytton, O.T., Townsend, N., Rutter, H., & Foster, C. (2012). Green space and physical activity: An observational study using Health Survey for England data. *Health & Place, 18*, 1034-1041.

Nafziger, A.N., Erb, T.A., Jenkins, P.L., Lewis, C., & Pearson, T.A. (2001). The Otsego-Schoharie healthy heart program: prevention of cardiovascular disease in the rural US. *Scandinavian Journal of Public Health Supplement, 56*, 21-32.

National Institute for Health and Clinical Excellence. (2008). Promoting and creating built or natural environments that encourage and support physical activity. London: National Institute for Health and Clinical Excellence.

NSW Health Department. (2002). 'Walk It: Active Local Parks' Summary Report. North Sydney: NSW Health Department.

Nutbeam, D., & Bauman, A. (2006). Evaluation in a Nutshell: A practical guide to the evaluation of health promotion programs. McGraw-Hill Medical, North Ryde, NSW.

Nutbeam, D., Harris, E., & Wise, M. (2010). Theory in a Nutshell (3rd Edition). McGraw-Hill Medical, North Ryde, NSW. p17-19.

O'Loughlin, J.L., Paradis, G., Gray-Donald, K., & Renaud, L. (1999). The impact of a community-based heart disease prevention program in a low-income, inner-city neighbourhood. *American Journal of Public Health, 89*(12), 1819-1826.

Office for National Statistics. (2001). Rural/Urban Definition 2001 (England and Wales). Retrieved from: www.ons.gov.uk/ons/guide-method/geography/ products/area-classifications/rural-urban-definition-and-la/rural-urban-definition—england-and-wales-/index.html.

Ogilvie, D., Griffin, S.J., Jones, A., Mackett, R., Guell, C., Panter, J., Jones, N., Cohn, S., Yang, L., & Chapman, C. (2010). Commuting and health in Cambridge: a study of a 'natural experiment' in the provision of new transport infrastructure. *BMC Public Health*, *10*, 703.

Ogilvie, D., Mitchell, R., Mutrie, N., Petticrew, M., & Platt, S. (2008). Perceived characteristics of the environment associated with active travel: development and testing of a new scale. *International Journal of Behavioral Nutrition and Physical Activity*, *5,* 32.

Oliveira-Brochado, A., Oliveira-Brochado, F., & Quelhas Brito, P. (2010). Effects of personal, social and environmental factors on physical activity behavior among adults. *Revista Portuguesa de Saude Publica*, *28*(1), 7-17.

Orsini, N., Bellocco, R., Bottai, M., Pagano, M., & Wolk, A. (2007). Correlates of total physical activity among middle-aged and elderly women. *International Journal of Behavioral Nutrition and Physical Activity, 4,* 16.

Osler, M., & Jespersen, N.B. (1993). The effect of a community-based cardiovascular disease prevention project in a Danish municipality. *Danish Medical Bulletin, 40*, 485-489.

Oxford Consultants for Social Inclusion (OCSI). (2009). Rural deprivation in the South West. London: Oxford Consultants for Social Inclusion.

Paffenbarger, R.S., Blair, S.N., Lee, I.M., & Hyde, R.T. (1993). Measurement of physical activity to assess health effect in free-living populations. *Medicine and Science in Sports and Exercise, 25*, 60-70.

Pan, S.Y., Cameron, C., Desmeules, M., Morrison, H., Craig, C.L., & Jiang, X. (2009). Individual, social, environmental, and physical environmental correlates with physical activity among Canadians: a cross-sectional study. *BMC Public Health. 9,* 21.

Panter, J., Griffin, S., & Ogilvie, D. (2012). Correlates of reported and recorded time spent in physical activity in working adults: results from the commuting and health in Cambridge study. *PLoS One, 7*(7), e42202.

Parks, S.E., Housemann, R.A., & Brownson, R.C. (2003). Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. *Journal of Epidemiology and Community Health*, 57(1), 29-35.

Pekmezi, D., & Jennings, E. (2009). Interventions to promote physical activity among African Americans. *American Journal of Lifestyle Medicine, 3*, 173-184.

Pereira, M.A., Fitzgerald, S.J., Gregg, E.W., Joswiak, M.L., Ryan, W.J., Suminski, R.R., Utter, A.C., & Zmuda, J.M. (1997). A collection of physical activity questionnaires. *Medicine and Science in Sports and Exercise, 29*, 1-203.

Plotnikoff, R.C., Mayhew, A., Birkett, N., Loucaides, C.A., & Fodor, G. (2004). Age, gender, and urban-rural differences in the correlates of physical activity. *Preventive Medicine, 39*(6), 1115-1125.

Priestly, G., Watson, W., Rashidian, A., Mozley, C., Russell, D., Wilson, J., Cope, J., Hart, D., Kay, D., Cowley, K., & Pateraki, J. (2004). Introducing Critical Care Outreach: a ward-randomised trial of phased introduction in a general hospital. *Intensive Care Medicine, 30*(7), 1398-1404.

Public Health England. (2010). Health Impact of Physical Inactivity (HIPI), developed and supported by SWPHO, Sustrans and the South West Public Health training scheme. Retrieved from http://www.apho.org.uk/addons/_122359/atlas.html.

Purdon, S., Lessof, C., Woodfield, K., & Bryson, C. (2001). Research Methods for Policy Evaluation. Department for Work and Pensions Research Working Paper No 2. London.

Reger, B., Cooper, L., Booth-Butterfield, S., Smith, H., Bauman, A., Wootan, M., Middlestadt, S., Marcus, B., & Greer, F. (2002). Wheeling Walks: a community campaign using paid media to encourage walking among sedentary older adults. *Preventive Medicine, 35*(3), 285-292.

Reger-Nash, B., Bauman, A., Booth-Butterfield, S., Cooper, L., Smith, H., Chey, T., & Simon, K.J. (2005). Wheeling walks: evaluation of a media-based community intervention. *Family and Community Health, 28*(1), 64-78.

Reger-Nash, B., Bauman, A., Cooper, L., Chey, T., Simon, K.J., Brann, M., & Leyden, K.M. (2008). WV Walks: replication with expanded reach. *Journal of Physical Activity and Health, 5*(1), 19-27.

Reger-Nash, B., Fell, P., Spicer, D., Fisher, B.D., Cooper, L., Chey, T., & Bauman, A. (2006). BC Walks: replication of a communitywide physical activity campaign. *Preventing Chronic Disease, 3*(3), A90.

Rennie, K.L., Hennings, S.J., Mitchell, J., & Wareham, N.J. (2001). Estimating energy expenditure by heart-rate monitoring without individual calibration. *Medicine and Science in Sports and Exercise, 33*, 939-945.

Rennie, K., Rowsell, T., Jebb, S.A., Holburn, D., & Wareham, N.J. (2000). A combined heart rate and movement sensor: proof of concept and preliminary testing study. *European Journal of Clinical Nutrition, 54,* 409-414.

Resnicow, K., Jackson, A., Blisset, D., Wang, T., McCarty, F., Rahotep, S., & Periasamy, S. (2005). Results of the Healthy Body Healthy Spirit trial. *Healthy Psychology*, *24*, 339-348.

Rhodes, R.E., Martin, A.D., Taunton, J.E., Rhodes, E.C., Donnelly, M., & Elliot, J. (1999). Factors associated with exercise adherence among older adults: an individual perspective. *Sports Medicine, 28*, 397-411.

Rice, N., & Leyland, A. (1996). Multilevel models: applications to health data. *Journal of Health Services Research & Policy, 1,* 154-164.

Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical Activity Associated with Public Transport Use – A Review and Modelling of Potential Benefits. *International Journal of Environmental Research and Public Health*, *9*(7), 2454-2478.

Rissel, C.E., New, C., Wen, L.M., Merom, D., Bauman, A.E., & Garrard, J. (2010). The effectiveness of community-based cycling promotion: findings from the Cycling Connecting Communities project in Sydney, Australia. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 8.

Rothney, M.P., Apker, G.A., Song, Y., & Chen, K.Y. (2008). Comparing the performance of three generations of ActiGraph accelerometers. *Journal of Applied Physiology, 105*, 1091-1097.

Rothwell, P.M. (2005). External validity of randomised controlled trials: "To whom do the results of this trial apply?". *The Lancet, 365*, 82-93.

Rowland, M.L. (1990). Self-reported weight and height. *American Journal of Clinical Nutrition, 52*(6), 1125-1133.

Rzewnicki, R., Auweele, Y.V., & De Bourdeaudhuij, I. (2003). Addressing overreporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. *Public Health Nutrition, 6*(3), 299-305.

Saelens, B.E., Sallis, J.F., & Frank, L.D. (2002). Environmental correlates of walking and cycling: findings from the transportation, urban design and planning literatures. *Annals of Behavioral Medicine, 25*, 80-91.

Saelens, B.E., Sallis, J.F., Frank, L.D., Cain, K.L., Conway, T.L., Chapman, J.E., Slymen, D.J., & Kerr, J. (2012) Neighborhood environment and psychosocial correlates of adults' physical activity. *Medicine and Science in Sports and Exercise, 44*(4), 637-646.

Sahlqvist, S., Song, Y., Bull, F., Adams, E., Preston, J., & Ogilvie, D. (2011). Effect of questionnaire length, personalisation and reminder type on response rate to a complex postal survey: randomised controlled trial. *BMC Medical Research Methodology, 11*.

Sallis, J.F. (1991). Self-report measures of children's physical activity. *Journal of School Health, 61*, 215-219.

Sallis, J.F., Johnson, M.F., Calfas, K.J., Caparosa, S., & Nichols, J.F. (1997). Assessing perceived physical environmental variables that may influence physical activity. *Research Quarterly for Exercise and Sport*, *68,* 345-351.

Sallis, J.F., & Owen, N. (1997). Ecological models. In: Glanz, K.M., Lewis, F., & Rimer, B.K. (Eds.), Health Behavior and Health Education: Theory, Research, and Practice (pp. 403-424), 2nd Edition. San Francisco: Jossey-Bass.

Sallis, J. F., & Owen, N. (2002). Ecological models of health behavior. In Glanz, K.M., Lewis, F., & Rimer, B.K. (Eds.), Health Behavior and Health Education (pp. 462-484). New York: Wiley.

Sallis, J.F., Owen, N., & Fisher, E.B. (2008). Ecological models of health behavior. In: Glanz, K., Rimer, B.K., & Viswanath, K. (Eds.), Health Behavior and Health Education: Theory, Research, and Practice (pp. 465-486), 4th Edition. San Francisco: Jossey-Bass.

Sallis, J.F., Owen, N., & Fotheringham, M.J. (2000). Behavioral epidemiology: a systematic framework to classify phases of research on health promotion and disease prevention. *Annals of Behavioral Medicine, 22,* 294-298.

Sanson-Fisher, R.W., Bonevski, B., Green, L.W., & D'Este, C. (2007). Limitations of the Randomized Controlled Trial in Evaluating Population-Based Health Interventions. *American Journal of Preventive Medicine, 33,* 155-161.

Scarborough, P., Bhatnagar, P., Wickramasinghe, K.K., Allender, S., Foster, C., & Rayner, M. (2011). The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 NHS costs. *Journal of Public Health*, *May,* 1-9.

Schall, R. (1991). Estimation in generalized linear models with random effects. *Biometrika, 78*(4), 719-727.

Schneider, P.L., Crouter, S.E., Lukajic, O., & Bassett, D.R. (2003). Accuracy and reliability of ten pedometers for measuring steps over a 400-m walk. *Medicine and Science in Sports and Exercise, 35,* 1779-1784.

Sehatzadeh, B., Noland, R.B., & Weiner, M.D. (2011). Walking frequency, cars, dogs, and the built environment. *Transportation Research Part A: Policy and Practice. 45*, 741-754.

Sharpe, P.A., Granner, M.L., Hutto, B.E., Wilcox, S., Peck, L., & Addy, C.L. (2008). Correlates of physical activity among African American and white women. *American Journal of Health Behavior, 32*(6), 701-713.

Shephard, R.J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine, 37*, 197-206.

Shores, K.A., West, S.T., Theriault, D.S., & Davison, E.A. (2009). Extra-individual correlates of physical activity attainment in rural older adults. *Journal of Rural Health, 25*(2), 211-218.

Sibbald, B., & Roland, M. (1998). Understanding controlled trials: Why are randomised controlled trials important? *British Medical Journal, 316*, 201.

Simon, C., Schweitzer, B., Oujaa, M., Wagner, A., Arveiler, D., Triby, E., Copin, N., Blanc, S., & Platat, C. (2008). Successful overweight prevention in adolescents by increasing physical activity: a 4-year randomized controlled intervention. *International Journal of Obesity, 32*(10), 1489-1498.

Singh, G.K. (2003). Area Deprivation and Widening Inequalities in US Mortality, 1969-1998. *American Journal of Public Health*, *93,* 1137-1143.

Sirard, J.R., & Pate, R.R. (2001). Physical activity assessment in children and adolescents. *Sports Medicine, 31*, 439-454.

Smith, G., Gidlow, C., Davey, R., & Foster, C. (2010). What is my walking neighbourhood? A pilot study of English adults' definitions of their local walking neighbourhoods. *International Journal of Behavioral Nutrition and Physical Activity, 7*:34.

Somerville, M., Basham, M., Foy, C., Ballinger, G., Gay, T., Shute, P., & Barton, A.G. (2002). From local concern to randomised trial: the Watcombe Housing Project. *Health Expectations, 5,* 127-135.

StataCorp. (2011). *Stata Statistical Software: Release 12.* College Station, TX: StataCorp LP.

Strath, S.J., Bassett, D.R., Jr., Thompson, D.L., & Swartz, A.M. (2002). Validity of the simultaneous heart rate-motion sensor technique for measuring energy expenditure. *Medicine and Science in Sports and Exercise, 34*, 888-894.

Strath, S.J., Swartz, A.M., Bassett, D.R., O'Brien, W.L., King, G.A. & Ainsworth, B.E. (2000). Evaluation of heart rate as a method for assessing moderate intensity physical activity. *Medicine and Science in Sports and Exercise, 32,* S465-470.

Swainston, K., & Summerbell, C. (2008). The effectiveness of community engagement approaches and methods for health promotion interventions. Rapid Review: Phase 3 (including consideration of additional evidence from stakeholders). University of Teeside: NICE National Collaborating Centre.

Swartz, A.M., Strath, S.J., Bassett, D.R., O'Brien, W.L., King, G.A., & Ainsworth, B.E. (2000). Estimation of energy expenditure using CSA accelerometers at hip and wrist sites. *Medicine and Science in Sports and Exercise, 32*, S450-456.

The Research Excellence Framework. (2012). REF01.2012 Panel Criteria and Working Methods, HEFCE, January 2012.

Thomas, G.N., Macfarlane, D.J., Guo, B., Cheung, B.M., McGhee, S.M., Chou, K.L., Deeks, J.J., Lam, T.H., & Tomlinson, B. (2012). Health promotion in older Chinese: a 12-month cluster randomized controlled trial of pedometry and "peer support". *Medicine and Science in Sports and Exercise, 44*(6), 1157-1166.

Torgenson, D.J. (2001). Contamination in trials: is cluster randomisation the answer? *British Medical Journal, 322*(7282), 355-357.

Townsend, N., Bhatnagar, P., Wickramasinghe, K., Scarborough, P., Foster, C., & Rayner, M. (2012). Physical activity statistics 2012. London: British Heart Foundation.

Trost, S.G. (2001). Objective measurement of physical activity in youth: current issues, future directions. *Exercise and Sports Science Review, 29*, 33-36.

Trost, S.G. (2007). State of the art reviews: Measurement of physical activity in children and adolescents. *American Journal of Lifestyle Medicine, 1*(4), 299-314.

Trost, S.G., Mciver, K.L., & Pate, R.R. (2005). Conducting Accelerometer-Based Activity Assessments in Field-Based Research. *Medicine and Science in Sports and Exercise, 37*, S531-543.

Trost, S.G., Owen, N., Bauman, A.E., Sallis, J.F., & Brown, W. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise, 34*(12), 1996-2001.

Tudor-Locke, C., & Bassett, D.R. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine, 34*, 1-8.

Tudor-Locke, C., Burkett, L., Reis, J.P., Ainsworth, B.E., Macera, C.A., & Wilson, D.K. (2005). How many days of pedometer monitoring predict weekly physical activity in adults? *Preventive Medicine, 40*(3), 293-298.

Tudor-Locke, C., Sisson, S.B., Lee, S.M., Craig, C.L., Plotnikoff, R.C., & Bauman, A. (2006). Evaluation of quality of commercial pedometers. *Canadian Journal of Public Health, 97*, S10-15.

Tudor-Locke, C., Williams, J.E., Reis, J.P., & Pluto, D. (2002). Utility of pedometers for assessing physical activity: convergent validity. *Sports Medicine, 32,* 795-808.

UK Medical Research Council. (2013). Diet and Physical Activity Measurement Toolkit: Physical Activity Assessment. Retrieved from: www.dapa-toolkit.mrc.ac.uk/physical-activity-assessment/.

Unit DoCMaSS. (2002). Game Plan: A Strategy for Delivering Government's Sport and Physical Activity Objectives. London: Cabinet Office.

Van Dyck, D., Cardon, G., Deforche, B., Giles-Corti, B., Sallis, J.F., Owen, N., & De Bourdeaudhuij, I. (2011). Environmental and psychosocial correlates of

accelerometer-assessed and self-reported physical activity in Belgian adults. *International Journal of Behavioral Medicine, 18*(3), 235-245.

Van Stralen, M.M., de Vries, H., Muddle, A.N., Bolman, C., & Lechner, L. (2009). Determinants of initiation and maintenance of physical activity among older adults: a literature review. *Health Psychology Review, 3*, 147-207.

Wallerstein, N. (2006). What is the evidence on effectiveness of empowerment to improve health? Copenhagen: WHO Europe, Health Evidence Network.

Wareham, N.J. (2007). Epidemiological studies of physical activity and diabetes risk, and implications for diabetes prevention. *Applied Physiology, Nutrition, and Metabolism, 32*, 778-782.

Washburn, R.A. (2000). Assessment of physical activity in older adults. *Research Quarterly for Exercise & Sport, 71*, S79-88.

Welk, G.J., Differding, J.A., Thompson, R.W., Blair, S.N., Dziura, J., & Hart, P. (2000). The utility of the Digi-Walker step counter to assess daily physical activity patterns. *Medicine and Science in Sports and Exercise, 32*, S481-488.

Wendel-Vos, W., Droomers, M., Kremers, S., Brug, J., & van Lenthe, F. (2007). Potential environmental determinants of physical activity in adults: a systematic review. *Obesity Review, 8*, 425-440.

Wendel-Vos, G.C., Dutman, A.E., Verschuren, W.M., Ronckers, E.T., Ament, A., van Assema, P., van Ree, J., Ruland, E.C., & Schuit, A.J. (2009). Lifestyle factors of a five-year community-intervention program: the Hartslag Limburg intervention. *American Journal of Preventive Medicine, 37*(1), 50-56.

Wilcox, S., Castro, C., King, A.C., Housemann, R., & Brownson, R.C. (2000). Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States. *Journal of Epidemiology and Community Health*, *54*, 667–672.

Wilcox, S., Parrott, A., Baruth, M., Laken, M., Condrasky, M., Saunders, R., Dowda, M., Evans, R., Addy, C., Warren, T.Y., Kinnard, D., & Zimmerman, L. (2013). The Faith, Activity, and Nutrition program: a randomized controlled trial in African-American churches. *American Journal of Preventive Medicine, 44*(2), 122-131.

World Health Organization. (2008). Review of Best Practice in Interventions to Promote Physical Activity in Developing Countries. Background Document prepared for the WHO Workshop on Physical Activity and Public Health. Beijing, People's Republic of China: World Health Organization.

World Health Organization. (2009). Global Health Risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization.

World Health Organization. (2010). Global Recommendations on Physical Activity for Health. Geneva: World Health Organization.

Yousefian, A., Hennessy, E., Umstattd, M.R., Economos, C.D., Hallam, J.S., Hyatt, R.R., & Hartley, D. (2010). Development of the Rural Active Living Assessment Tools: measuring rural environments. *Preventive Medicine*, *50*(Suppl. 1), 86-92.

Zhang, Y., Zhao, Z.T., Li, G.R., Hao, F.R., Wang, S.M., & Pan, Y.Z. (2003). Effectiveness of community intervention on population's diabetes mellitus knowledge and its influencing factors. *Chinese Journal of Public Health, 19*(7), 888-889.

Zhang, K., Werner, P., Sun, M., Pi-Sunyer, F.X., & Boozer, C.N. (2003). Measuring of Human Daily Physical Activity. *Obesity Reviews, 11*, 33-40.

References for excluded studies in the systematic review of community-level physical activity interventions

Ayala, G.X., & San Diego Prevention Research Center Team. (2011). Effects of a promotor-based intervention to promote physical activity: Familias Sanas y Activas. *American Journal of Public Health*, *101*(12), 2261-2268.

Baker, G., Gray, S.R., Wright, A., Fitzsimons, C., Nimmo, M., Lowry, R., Mutrie, N., & Scottish Physical Activity Research Collaboration (SPARColl). (2010). The effect of a pedometer-based community walking intervention "Walking for Wellbeing in the West" on physical activity levels and health outcomes: a 12-week randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 7*, 51.

Bauman, A., McLean, G., Hurdle, D., Walker, S., Boyd, J., van Aalst, I., & Carr, H. (2003). Evaluation of the national 'Push Play' campaign in New Zealand—creating population awareness of physical activity. *New Zealand Medical Journal, 116*(1179), U535.

Chao, J., Wang, Y., Xu, H., Yu, Q., Jiang, L., Tian, L., Xie, W., & Liu, P. (2012). The effect of community-based health management on the health of the elderly: a randomized controlled trial from China. *BMC Health Services Research, 12*, 449.

Cheadle, A., Egger, R., LoGerfo, J.P., Schwartz, S., & Harris, J.R. (2010). Promoting sustainable community change in support of older adult physical activity: evaluation findings from the Southeast Seattle Senior Physical Activity Network (SESPAN). *Journal of Urban Health, 87*(1), 67-75.

Chomitz, V.R., McDonald, J.C., Aske, D.B., Arsenault, L.N., Rioles, N.A., Brukilacchio, L.B., Hacker, K.A., & Cabral, H.J. (2012). Evaluation results from an active living intervention in Somerville, Massachusetts. *American Journal of Preventive Medicine, 43*(5 Suppl 4), 367-378.

Croker, H., Lucas, R., & Wardle, J. (2012). Cluster-randomised trial to evaluate the 'Change for Life' mass media/ social marketing campaign in the UK. *BMC Public Health, 12*, 404.

Dirige, O.V., Carlson, J.A., Alcaraz, J., Moy, K.L., Rock, C.L., Oades, R., & Sallis, J.F. (2013). Siglang Buhay: nutrition and physical activity promotion in Filipino-Americans through community organizations. *Journal of Public Health Management and Practice, 19*(2), 162-168.

Duru, O.K., Sarkisian, C.A., Leng, M., & Mangione, C.M. (2010). Sisters in motion: a randomized controlled trial of a faith-based physical activity intervention. *Journal of the American Geriatrics Society, 58*(10), 1863-1869.

Farag, N.H., Moore, W.E., Thompson, D.M., Kobza, C.E., Abbott, K., & Eichner, J.E. (2010). Evaluation of a community-based participatory physical activity promotion project: effect on cardiovascular disease risk profiles of school employees. *BMC Public Health, 10,* 313.

Fisher, K.J., & Li, F. (2004). A community-based walking trial to improve neighborhood quality of life in older adults: a multilevel analysis. *Annals of Behavioral Medicine, 28*(3), 186-194.

Fitzpatrick, S.E., Reddy, S., Lommel, T.S., Fischer, J.G., Speer, E.M., Stephens, H., Park, S., & Johnson, M.A. (2008). Physical activity and physical function improved following a community-based intervention in older adults in Georgia senior centers. *Journal of Nutrition for the Elderly, 27*(1-2), 135-154.

Folta, S.C., Lichtenstein, A.H., Seguin, R.A., Goldberg, J.P., Kuder, J.F., & Nelson, M.E. (2009). The Strong Women-Healthy Hearts program: reducing cardiovascular disease risk factors in rural sedentary, overweight, and obese midlife and older women. *American Journal of Public Health, 99*(7), 1271-1277.

French, S.A., Gerlach, A.F., Mitchell, N.R., Hannan, P.J., & Welsh, E.M. (2011). Household obesity prevention: Take Action--a group-randomized trial. *Obesity (Silver Spring), 19*(10), 2082-2088.

From, S., Liira, H., Leppävuori, J., Remes-Lyly, T., Tikkanen, H., & Pitkälä, K. (2013). Effectiveness of exercise intervention and health promotion on cardiovascular risk factors in middle-aged men. A protocol of a randomized controlled trial. *BMC Public Health, 13*(1), 125.

Garmendia, M.L., Dangour, A.D., Albala, C., Eguiguren, P., Allen, E., & Uauy, R. (2013). Adherence to a physical activity intervention among older adults in a post-transitional middle income country: a quantitative and qualitative analysis. *Journal of Nutrition Health and Aging, 17*(5), 466-471.

Greaney, M.L., Riebe, D., Ewing Garber, C., Rossi, J.S., Lees, F.D., Burbank, P.A., Nigg, C.R., Ferrone, C.L., & Clark, P.G. (2008). Long-term effects of a stage-based intervention for changing exercise intentions and behavior in older adults. *Gerontologist, 48*(3), 358-367.

Gu, W. (2006). Study on the risk factors of hypertension and the evaluation of the comprehensive intervention in the rural community of Jiaxing. Master thesis of Zhejiang University, School of Public Health.

Guo, Y., Wang, H., Yan, H., Zhang, F., Gao, C., & Xiang, N., Fu, X., & Han, F. (2006). Evaluation on the effect of hypertension health education in country community. *Chinese Journal of Health Education, 22*(10), 770-772.

Hardcastle, S., Blake, N., & Hagger, M.S. (2012). The effectiveness of a motivational interviewing primary-care based intervention on physical activity and predictors of change in a disadvantaged community. *Journal of Behavioral Medicine, 35*(3), 318-333.

Haruyama, Y., Muto, T., Nakade, M., Kobayashi, E., Ishisaki, K., & Yamasaki, A. (2009). Fifteen-month lifestyle intervention program to improve cardiovascular risk factors in a community population in Japan. *The Tohoku Journal of Experimental Medicine, 217*(4), 259-269.

Hayashi, T., Farrell, M.A., Chaput, L.A., Rocha, D.A., & Hernandez, M. (2010). Lifestyle intervention, behavioral changes, and improvement in cardiovascular risk profiles in the California WISEWOMAN project. *Journal of Women's Health (Larchmt), 19*(6), 1129-1138.

Hendricks, K., Wilkerson, R., Vogt, C., & TenBrink, S. (2009). Transforming a small midwestern city for physical activity: from the sidewalks up. *Journal of Physical Activity and Health, 6*(6), 690-698.

Hersey, J.C., Khavjou, O., Strange, L.B., Atkinson, R.L., Blair, S.N., Campbell, S., Hobbs, C.L., Kelly, B., Fitzgerald, T.M., Kish-Doto, J., Koch, M.A., Munoz, B., Peele, E., Stockdale, J., Augustine, C., Mitchell, G., Arday, D., Kugler, J., Dorn, P., Ellzy, J., Julian, R., Grissom, J., & Britt, M. (2012). The efficacy and cost-effectiveness of a community weight management intervention: a randomized controlled trial of the health weight management demonstration. *Preventive Medicine, 54*(1), 42-49.

Hillier, F.C., Batterham, A.M., Nixon, C.A., Crayton, A.M., Pedley, C.L., & Summerbell, C.D. (2012). A community-based health promotion intervention using brief negotiation techniques and a pledge on dietary intake, physical activity levels and weight outcomes: lessons learnt from an exploratory trial. *Public Health Nutrition, 15*(8), 1446-1455.

Jiang, Y.Y., Yang, Z.X., Ni, R., Zhu, Y.Q., Li, Z.Y., Yang, L.C., Zhai, Y., & Zhao, W.H. (2013). Effectiveness analysis on the physical activity and the health benefit of a community population based program. *Biomedical and Environmental Sciences, 26*(6), 468-473.

Kegler, M.C., Alcantara, I., Veluswamy, J.K., Haardörfer, R., Hotz, J.A., & Glanz, K. (2012). Results from an intervention to improve rural home food and physical activity environments. *Progress in Community Health Partnerships, 6*(3), 265-277.

Kelishadi, R., Sarrafzadegan, N., Sadri, G.H., Pashmi, R., Mohammadifard, N., Tavasoli, A.A., Amani, A., Rabiei, K., Khosravi, A., & Bahonar, A. (2011). Short-term results of a community-based program on promoting healthy lifestyle for prevention and control of chronic diseases in a developing country setting: Isfahan Healthy Heart Program. *Asia Pacific Journal of Public Health, 23*(4), 518-533.

Kimura, M., Moriyasu, A., Kumagai, S., Furuna, T., Akita, S., Kimura, S., & Suzuki, T. (2013). Community-based intervention to improve dietary habits and promote physical activity among older adults: a cluster randomized trial. *BMC Geriatrics, 13*, 8.

Kontogianni, M.D., Liatis, S., Grammatikou, S., Perrea, D., Katsilambros, N., & Makrilakis, K. (2012). Changes in dietary habits and their association with

metabolic markers after a non-intensive, community-based lifestyle intervention to prevent type 2 diabetes, in Greece. The DEPLAN study. *Diabetes Research and Clinical Practice, 95*(2), 207-214.

Lombard, C.B., Deeks, A.A., Ball, K., Jolley, D., & Teede, H.J. (2009). Weight, physical activity and dietary behavior change in young mothers: short term results of the HeLP-her cluster randomized controlled trial. *Nutrition Journal, 8*, 17.

Lombard, C.B., Deeks, A.A., Jolley, D., Ball, K., & Teede, H.J. (2010). A low intensity, community based lifestyle programme to prevent weight gain in women with young children: cluster randomised controlled trial. *British Medical Journal, 341*, 3215.

Marshall, A.L., Bauman, A.E., Owen, N., Booth, M.L., Crawford, D., & Marcus, B.H. (2004). Reaching out to promote physical activity in Australia: a statewide randomized controlled trial of a stage-targeted intervention. *American Journal of Health Promotion, 18*(4), 283-287.

Martinson, B.C., Crain, A.L., Sherwood, N.E., Hayes, M., Pronk, N.P., & O'Connor, P.J. (2008). Maintaining physical activity among older adults: six-month outcomes of the Keep Active Minnesota randomized controlled trial. *Preventive Medicine, 46*(2), 111-119.

McCracken, J.L., Friedman, D.B., Brandt, H.M., Adams, S.A., Xirasagar, S., Ureda, J.R., Mayo, R.M., Comer, K., Evans, M., Fedrick, D., Talley, J., Broderick, M., & Hebert, J.R. (2013). Findings from the Community Health Intervention Program in South Carolina: Implications for Reducing Cancer-Related Health Disparities. *Journal of Cancer Education, May 5* [Epub ahead of print].

Mendonça, B.C., Oliveira, A.C., Toscano, J.J.O., Knuth, A.G., Borges, T.T., Malta, D.C., Cruz, D.K., & Hallal, P.C. (2010). Exposure to a community-wide physical activity promotion program and leisure-time physical activity in Aracaju, Brazil. *Journal of Physical Activity and Health, 7* (Suppl 2), 223-228.

Morgan, P.J., Collins, C.E., Plotnikoff, R.C., McElduff, P., Burrows, T., Warren, J.M., Young, M.D., Berry, N., Saunders, K.L., Aguiar, E.J., & Callister, R. (2010). The SHED-IT community trial study protocol: a randomised controlled trial of weight loss programs for overweight and obese men. *BMC Public Health, 10,* 701.

Nguyen, Q.N., Pham, S.T., Nguyen, V.L., Weinehall, L., Wall, S., Bonita, R., & Byass, P. (2012). Effectiveness of community-based comprehensive healthy lifestyle promotion on cardiovascular disease risk factors in a rural Vietnamese population: a quasi-experimental study. *BMC Cardiovascular Disorders, 12,* 56.

Parra-Medina, D., Wilcox, S., Salinas, J., Addy, C., Fore, E., Poston, M., & Wilson, D.K. (2011). Results of the Heart Healthy and Ethnically Relevant Lifestyle trial: a cardiovascular risk reduction intervention for African American women attending community health centers. *American Journal of Public Health, 101*(10), 1914-1921.

Pasalich, M., Lee, A.H., Jancey, J., Burke, L., & Howat, P. (2013). Sustainability of a physical activity and nutrition program for seniors. *Journal of Nutrition Health and Aging, 17*(5), 486-491.

Pazoki, R., Nabipour, I., Seyednezami, N., & Imami, S.R. (2007). Effects of a community-based healthy heart program on increasing healthy women's physical activity: a randomized controlled trial guided by Community-based Participatory Research (CBPR). *BMC Public Health, 7*, 216.

Pelssers, J., Delecluse, C., Opdenacker, J., Kennis, E., Van Roie, E., & Boen, F. (2013). "Every step counts!": effects of a structured walking intervention in a community-based senior organization. *Journal of Aging and Physical Activity, 21*(2), 167-185.

Rabiei, K., Kelishadi, R., Sarrafzadegan, N., Sadri, G., & Amani, A. (2010). Short-term results of community-based interventions for improving physical activity: Isfahan Healthy Heart Programme. *Archives of Medical Science, 6*(1), 32-39.

Reichenpfader, U., Thaler, K., Richter, A., Thieda, P., & Gartlehner, G. (2012). Clinical outcomes, health-related quality of life, and cost-effectiveness of a 6-month community-based lifestyle program for adults at increased cardiovascular risk in lower Austria. *Wiener Medizinische Wochenschrift, 162*(15-16), 321-329.

Richardson, C.R., Buis, L.R., Janney, A.W., Goodrich, D.E., Sen, A., Hess, M.L., Mehari, K.S., Fortlage, L.A., Resnick, P.J., Zikmund-Fisher, B.J., Strecher, V.J., & Piette, J.D. (2010). An online community improves adherence in an internet-mediated walking program. Part 1: results of a randomized controlled trial. *Journal of Medical Internet Research, 12*(4), e71.

Sadeghi, M., Aghdak, P., Motamedi, N., Tavassoli, A., Kelishadi, R., & Sarrafzadegan, N. (2011). Do Intervention Strategies of Women Healthy Heart Project (WHHP) Impact on Differently on Working and Housewives? *AYRA Atherosclerosis, 6*(4), 129-135.

Sayers, S.P., LeMaster, J.W., Thomas, I.M., Petroski, G.F., & Ge, B. (2012). Bike, walk, and wheel: a way of life in Columbia, Missouri, revisited. *American Journal of Preventive Medicine, 43*(5 Suppl 4), 379-383.

Sharpe, P.A., Burroughs, E.L., Granner, M.L., Wilcox, S., Hutto, B.E., Bryant, C.A., Peck, L., & Pekuri, L. (2010). Impact of a community-based prevention marketing intervention to promote physical activity among middle-aged women. *Health Education and Behavior, 37*(3), 403-423.

Simoes, E.J., Hallal, P., Pratt, M., Ramos, L., Munk, M., Damascena, W., Perez, D.P., Hoehner, C.M., Gilbertz, D., Malta, D.C., & Brownson, R.C. (2009). Effects of a community-based, professionally supervised intervention on physical activity levels among residents of Recife, Brazil. *American Journal of Public Health, 99*(1), 68-75.

Suminski, R.R., Petosa, R.L., Jones, L., Hall, L., & Poston, C.W. (2009). Neighborhoods on the move: a community-based participatory research approach to promoting physical activity. *Progress in Community Health Partnerships, 3*(1), 19-29.

Tanaka, C., Fujiwara, Y., Yasunaga, M., Sakurai, R., Saito, K., Kim, H., Fukaya, T., Nonaka, K., Kobayashi, K., Yoshida, H., Uchida, H., Shinkai, S., & Watanabe, S. (2012). Effects of comprehensive intervention program to habitual physical activity in community-dwelling older adults. *Nihon Ronen Igakkai Zasshi, 49*(3), 372-374.

Tudor-Smith, C., Nutbeam, D., Moore, L., & Catford, J. (1998). Effects of the Heartbeat Wales programme over five years on behavioural risks for cardiovascular disease: quasi-experimental comparison of results from Wales and a matched reference area. *British Medical Journal, 316*(7134), 818-822.

Van Acker, R., De Bourdeaudhuij, I., De Cocker, K., Klesges, L.M., & Cardon, G. (2011). The impact of disseminating the whole-community project '10,000 Steps': a RE-AIM analysis. *BMC Public Health, 11*, 3.

Van Acker, R., De Bourdeaudhuij, I., De Cocker, K., Klesges, L.M., Willem, A., & Cardon, G. (2012). Sustainability of the whole-community project '10,000 Steps': a longitudinal study. *BMC Public Health, 12*, 155.

Van Hoecke, A.S., Delecluse, C., Opdenacker, J., Lipkens, L., Martien. S., & Boen, F. (2013). Long-term effectiveness and mediators of a need-supportive physical activity coaching among Flemish sedentary employees. *Health Promotion International, 28*(3), 407-417.

Vio, F., Lera, L., & Zacaría, I. (2011). Evaluation of a nutrition education and physical activity intervention in Chilean low socioeconomic women. *Archivos Latinoamericanos de Nutricion, 61*(4), 406-413.

Wellman, N.S., Kamp, B., Kirk-Sanchez, N.J., & Johnson, P.M. (2007). Eat better & move more: a community-based program designed to improve diets and increase physical activity among older Americans. *American Journal of Public Health, 97*(4), 710-717.

Wen, L.M., Thomas, M., Jones, H., Orr, N., Moreton, R., King, L., Hawe, P., Bindon, J., Humphries, J., Schicht, K., Corne, S., & Bauman, A. (2002). Promoting physical activity in women: evaluation of a 2-year community-based intervention in Sydney, Australia. *Health Promotion International, 17*(2), 127-137.

Wilcox, S., Dowda, M., Dunn, A., Ory, M.G., Rheaume, C., & King, A.C. (2009). Predictors of increased physical activity in the Active for Life program. *Preventing Chronic Disease, 6*(1), A25.

Wilcox, S., Dowda, M., Leviton, L.C., Bartlett-Prescott, J., Bazzarre, T., Campbell-Voytal, K., Carpenter, R.A., Castro, C.M., Dowdy, D., Dunn, A.L., Griffin, S.F., Guerra, M., King, A.C., Ory, M.G., Rheaume, C., Tobnick, J., & Wegley, S. (2008). Active for life: final results from the translation of two

physical activity programs. *American Journal of Preventive Medicine, 35*(4), 340-351.

Yan, T., Wilber, K.H., Aguirre, R., & Trejo, L. (2009). Do sedentary older adults benefit from community-based exercise? Results from the Active Start program. *Gerontologist, 49*(6), 847-855.

Ziebarth, D., Healy-Haney, N., Gnadt, B., Cronin, L., Jones, B., Jensen, E., & Viscuso, M. (2012). A community-based family intervention program to improve obesity in Hispanic families. *Wisconsin Medical Society, 111*(6), 261-266.

References for excluded studies in the systematic review of physical activity correlates

Ainsworth, B.E., Wilcox, S., Thompson, W.W., Richter, D.L., & Henderson, K.A. (2003). Personal, social, and physical environmental correlates of physical activity in African-American women in South Carolina. *American Journal of Preventive Medicine, 25*(3 Suppl 1), 23-29.

Ammouri, A.A., Neuberger, G., Nashwan, A.J., & Al-Haj, A.M. (2007). Determinants of self-reported physical activity among Jordanian adults. *Journal of Nursing Scholarship, 39*(4), 342-348.

Aparicio-Ting, F.E., Friedenreich, C.M., Plotnikoff, R.C., & Bryant, H.E. (2013). Intrapersonal and Social Environment Correlates of Leisure-Time Physical Activity for Cancer Prevention: A Cross-Sectional Study Among Canadian Adults. *Journal of Physical Activity & Health,* Apr 5. [Epub ahead of print]

Bauman, A.E., Reis, R.S., Sallis, J.F., Wells, J.C., Loos, R.J., Martin, B.W., & Lancet Physical Activity Series Working Group. (2012). Correlates of physical activity: why are some people physically active and others not? *Lancet, 380*(9838), 258-271.

Biernat, E., & Tomaszewski, P. (2011). Socio-demographic and leisure activity determinants of physical activity of working warsaw residents aged 60 to 69 years. *Journal of Human Kinetics, 30*, 173-181.

Blanchard, C.M., McGannon, K.R., Spence, J.C., Rhodes, R.E., Nehl, E., Baker, F., & Bostwick, J. (2005). Social ecological correlates of physical activity in normal weight, overweight, and obese individuals. *International Journal of Obesity, 29*(6), 720-726.

Bungum, T.J., Landers, M., Azzarelli, M., & Moonie, S. (2012). Perceived environmental physical activity correlates among Asian Pacific Islander Americans. *Journal of Physical Activity & Health, 9*(8), 1098-1104.

Bungum, T.J., Thompson-Robinson, M., Moonie, S., & Lounsbery, M.A.F. (2011). Correlates of physical activity among Hispanic adults. *Journal of Physical Activity & Health, 8*(3), 429-435.

Burton, L.C., Shapiro, S., & German, P.S. (1999). Determinants of physical activity initiation and maintenance among community-dwelling older persons. *Preventive Medicine, 29*(5), 422-430.

Carter-Parker, K., Edwards, K.A., & McCleary-Jones, V. (2012). Correlates of physical activity and the theory of planned behavior between African American women who are physically active and those who are not. *ABNF Journal, 23*(3), 51-58.

Caudroit, J., Stephan, Y., & Le Scanff, C. (2011). Social cognitive determinants of physical activity among retired older individuals: an application of the health

action process approach. *British Journal of Health Psychology, 16*(Pt 2), 404-417.

Chen, Y.J., Huang, Y.H., Lu, F.H., Wu, J.S., Lin, L.L., Chang, C.J., & Yang, Y.C. (2011). The correlates of leisure time physical activity among an adults population from southern Taiwan. *BMC Public Health, 11,* 427.

De Bourdeaudhuij, I., Sallis, J.F., & Saelens, B.E. (2003). Environmental correlates of physical activity in a sample of Belgian adults. *American Journal of Health Promotion, 18*(1), 83-92.

Del Duca, G.F., Nahas, M.V., Garcia, L.M., Mota, J., Hallal, P.C., & Peres, M.A. (2013). Prevalence and sociodemographic correlates of all domains of physical activity in Brazilian adults. *Preventive Medicine, 56*(2), 99-102.

Eyler, A.A. (2003). Correlates of physical activity: who's active and who's not? *Arthritis & Rheumatism, 49*(1), 136-140.

Eyler, A.E., Wilcox, S., Matson-Koffman, D., Evenson, K.R., Sanderson, B., Thompson, J., Wilbur, J., & Rohm-Young, D. (2002). Correlates of physical activity among women from diverse racial/ethnic groups. *Journal of Women's Health & Gender-Based Medicine, 11*(3), 239-253.

Gallagher, P., Yancy, W.S., Denissen, J.J., Kühnel, A., & Voils, C.I. (2012). Correlates of Daily Leisure-Time Physical Activity in a Community Sample: Narrow Personality Traits and Practical Barriers. *Health Psychology*, Oct 1 [Epub ahead of print].

Garcia Bengoechea, E., Spence, J.C., & McGannon, K.R. (2005). Gender differences in perceived environmental correlates of physical activity. *International Journal of Behavioral Nutrition and Physical Activity, 2*,12.

Gómez, L.F., Mateus, J.C., & Cabrera, G. (2004). Leisure-time physical activity among women in a neighbourhood in Bogotá, Colombia: prevalence and socio-demographic correlates. *Cadernos de Saude Publica, 20*(4), 1103-1109.

Haley, C. & Andel, R. (2010). Correlates of physical activity participation in community-dwelling older adults. *Journal of Aging and Physical Activity, 18*(4), 375-389.

Hoerster, K.D., Mayer, J.A., Sallis, J.F., Pizzi, N., Talley, S., Pichon, L.C., & Butler, D.A. (2011). Dog walking: its association with physical activity guideline adherence and its correlates. *Preventive Medicine, 52*(1), 33-38.

Ishii, K., Shibata, A., & Oka, K. (2011). Meeting physical activity recommendations for colon cancer prevention among Japanese adults: prevalence and sociodemographic correlates. *Journal of Physical Activity & Health, 8*(7), 907-915.

Ishii, K., Shibata, A., & Oka, K. (2013). Identifying environmental, social, and psychological correlates of meeting the recommended physical activity levels

for colon cancer prevention among Japanese adults. *Journal of Science and Medicine in Sport,* Feb 6 [Epub ahead of print].

Jaime, P.C., Duran, A.C., Sarti, F.M., & Lock, K. (2011). Investigating environmental determinants of diet, physical activity, and overweight among adults in Sao Paulo, Brazil. *Journal of Urban Health, 88*(3), 567-581.

James, A.S., Hudson, M.A., & Campbell, M.K. (2003). Demographic and psychosocial correlates of physical activity among African Americans. *American Journal of Health Behavior, 27*(4), 421-431.

Jurj, A.L., Wen, W., Gao, Y.T., Matthews, C.E., Yang, G., Li, H.L., Zheng, W., & Shu, X.O. (2007). Patterns and correlates of physical activity: a cross-sectional study in urban Chinese women. *BMC Public Health, 7,* 213.

Kamada, M., Kitayuguchi, J., Inoue, S., Kamioka, H., Mutoh, Y., & Shiwaku, K. (2009). Environmental correlates of physical activity in driving and non-driving rural Japanese women. *Preventive Medicine, 49*(6), 490-496.

Katulanda, P., Jayawardana, R., Ranasinghe, P., Rezvi Sheriff, M., & Matthews, D.R. (2013). Physical activity patterns and correlates among adults from a developing country: the Sri Lanka Diabetes and Cardiovascular Study. *Public Health Nutrition, 16*(9), 1684-1692.

King, A.C., Toobert, D., Ahn, D., Resnicow, K., Coday, M., Riebe, D., Garber, C.E., Hurtz, S., Morton, J., & Sallis, J.F. Perceived environments as physical activity correlates and moderators of intervention in five studies. *American Journal of Health Promotion, 21(*1), 24-35.

Kirk, M.A., & Rhodes, R.E. (2011). Occupation correlates of adults' participation in leisure-time physical activity: a systematic review. *American Journal of Preventive Medicine, 40*(4), 476-485.

Koeneman, M.A., Verheijden, M.W., Chinapaw, M.J., & Hopman-Rock, M. (2011). Determinants of physical activity and exercise in healthy older adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 8*, 142.

La Torre, G., Larocci, G., Quaranta, G., Mannocci, A., & Ricciardi, G. (2006). Socio-demographic determinants of physical activity in Italy. *Igiene e Sanita Pubblica, 62*(3), 267-278.

Lee, S.A., Xu, W.H., Zheng, W., Li, H., Yang, G., Xiang, Y.B., & Shu, X.O. (2007). Physical activity patterns and their correlates among Chinese men in Shanghai. *Medicine and Science in Sports and Exercise, 39*(10), 1700-1707.

Łobaszewski, J., Przewoźniak, K., Zatońska, K., Wojtyła, A., Bylina, J., Mańczuk, M., & Zatoński, W.A. (2011). Patterns of leisure time physical activity and its determinants among a sample of adults from Kielce region, Poland - the 'PONS' study. Annals of Agricultural and Environmental Medicine, 18(2), 241-245.

McNaughton, S.A., Crawford, D., Ball, K., & Salmon, J. (2012). Understanding determinants of nutrition, physical activity and quality of life among older adults: the Wellbeing, Eating and Exercise for a Long Life (WELL) study. *Health and Quality of Life Outcomes, 10,* 109.

McTiernan, A., Stanford, J.L., Daling, J.R., & Voigt, L.F. (1998). Prevalence and correlates of recreational physical activity in women aged 50-64 years. *Menopause, 5*(2), 95-101.

Mier, N., Ory, M.G., Zhan, D., Wang, S., & Burdine, J.N. (2007). Levels and correlates of exercise in a border mexican american population. *American Journal of Health Behavior, 31*(2), 159-169.

Momenan, A.A., Delshad, M., Mirmiran, P., Ghanbarian, A., & Azizi, F. (2011). Leisure Time Physical Activity and Its Determinants among Adults in Tehran: Tehran Lipid and Glucose Study. *International Journal of Preventive Medicine, 2*(4), 243-251.

Mullie, P., Collee, A., & Clarys, P. (2013). Socioeconomic, health, and dietary determinants of physical activity in a military occupational environment. *Military Medicine, 178*(5), 495-499.

Najdi, A., El Achhab, Y., Nejjari, C., Norat, T., Zidouh, A., & El Rhazi, K. (2011). Correlates of physical activity in Morocco. *Preventive Medicine, 52*(5), 355-357.

Nishida, Y., Suzuki, H., Wang, D.H., & Kira, S. (2003). Psychological determinants of physical activity in Japanese female employees. *Journal of Occupational Health, 45*(1), 15-22.

Ogwumike, O.O., Kaka, B., Adegbemigun, O., & Abiona, T. (2012). Health-related and socio-demographic correlates of physical activity level amongst urban menopausal women in Nigeria. *Maturitas, 73*(4), 349-353.

Oka, K., & Shibata, A. (2012). Determinants of meeting the public health recommendations for physical activity among community-dwelling elderly Japanese. *Current Aging Science, 5*(1), 58-65.

Olsen, J.M. (2013). An integrative review of literature on the determinants of physical activity among rural women. *Public Health Nursing, 30*(4), 288-311.

Owen, N., Leslie, E., Salmon, J., & Fotheringham, M.J. (2000). Environmental determinants of physical activity and sedentary behavior. *Exercise and Sport Science Reviews, 28*(4), 153-158.

Oyeyemi, A.L., Adegoke, B.O., Oyeyemi, A.Y., & Sallis, J.F. (2011). Perceived environmental correlates of physical activity and walking in African young adults. *American Journal of Health Promotion, 25*(5), 10-19.

Parra, D.C., Hoehner, C.M., Hallal, P.C., Ribeiro, I.C., Reis, R., Brownson, R.C., Pratt, M., & Simoes, E.J. (2011). Perceived environmental correlates of physical activity for leisure and transportation in Curitiba, Brazil. *Preventive Medicine, 52*(3-4), 234-238.

Perez, D.F., Ritvo, P.G., Brown, P.E., Holowaty, E., & Ardern, C. (2011). Perceived walkability, social support, age, native language, and vehicle access as correlates of physical activity: a cross-sectional study of low-socioeconomic status, ethnic, minority women. *Journal of Physical Activity and Health, 8*(8), 1098-1107.

Plonczynski, D.J. (2003). Physical activity determinants of older women: what influences activity? *Medsurg Nursing, 12*(4), 213-221.

Rhodes, R.E., & Smith, N.E. (2006). Personality correlates of physical activity: a review and meta-analysis. *British Journal of Sports Medicine, 40*(12), 958-965.

Rodríguez-Romo, G., Cordente, C.A., Mayorga, J.I., Garrido-Muñoz, M., Macías, R., Lucía, A., & Ruiz, J.R. (2011). Influence of socio-demographic correlates on the adherence to physical activity recommendations in adults aged from 15-to 74 years. *Revista Espanola de Salud Publica, 85*(4), 351-362.

Rohm Young, D., & Voorhees, C.C. (2003). Personal, social, and environmental correlates of physical activity in urban African-American women. *American Journal of Preventive Medicine, 25*(3 Suppl. 1), 38-44.

Romaguera, D., Tauler, P., Bennasar, M., Pericas, J., Moreno, C., Martinez, S., & Aguilo, A. (2011). Determinants and patterns of physical activity practice among Spanish university students. *Journal of Sports Science, 29*(9), 989-997.

Saito, Y., Oguma, Y., Inoue, S., Tanaka, A., & Kobori, Y. (2013). Environmental and individual correlates of various types of physical activity among community-dwelling middle-aged and elderly Japanese. *International Journal of Environmental Research and Public Health, 10*(5), 2028-2042.

Sanderson, B.K., Foushee, H.R., Bittner, V., Cornell, C.E., Stalker, V., Shelton, S., & Pulley, L. (2003). Personal, social, and physical environmental correlates of physical activity in rural African-American women in Alabama. *American Journal of Preventive Medicine, 25*(3 Suppl. 1), 30-37.

Schmitz, K., French, S.A., & Jeffery, R.W. (1997). Correlates of changes in leisure time physical activity over 2 years: the Healthy Worker Project. *Preventive Medicine, 26*(4), 570-579.

Sherwood, N.E., & Jeffery, R.W. (2000). The behavioral determinants of exercise: implications for physical activity interventions. *Annual Review of Nutrition, 20*, 21-44.

Shibata, A., Oka, K., Nakamura, Y., & Muraoka, I. (2009). Prevalence and demographic correlates of meeting the physical activity recommendation among Japanese adults. *Journal of Physical Activity and Health, 6*(1), 24-32.

Sigmundová, D., El Ansari, W., & Sigmund, E. (2011). Neighbourhood environment correlates of physical activity: a study of eight Czech regional towns. *International Journal of Environmental Research and Public Health, 8*(2), 341-357.

Steindorf, K., Chang-Claude, J., Flesch-Janys, D., & Schmidt, M.E. (2010). Determinants of sports, cycling, walking and overall leisure-time physical activity among postmenopausal women in Germany. *Public Health Nutrition, 13*(11), 1905-1914.

Steptoe, A., Wardle, J., Fuller, R., Holte, A., Justo, J., Sanderman, R., & Wichstrøm, L. (1997). Leisure-time physical exercise: prevalence, attitudinal correlates, and behavioral correlates among young Europeans from 21 countries. *Preventive Medicine, 26*(6), 845-854.

Stutts, W.C. (2002). Physical activity determinants in adults. Perceived benefits, barriers, and self efficacy. *AAOHN Journal, 50*(11), 499-507.

Suzuki, C.S., Moraes, S.A., & Freitas, I.C. (2011). Physical activity and correlates among adults living in Ribeirão Preto, Southeastern Brazil. *Revista de Saude Publica, 45*(2), 311-320.

Trost, S.G., Owen, N., Bauman, A.E., Sallis, J.F., & Brown, W. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise, 34*(12), 1996-2001.

Vagetti, G.C., Barbosa Filho, V.C., Moreira, N.B., de Oliveira, V., Mazzardo, O., & de Campos, W. (2013). The prevalence and correlates of meeting the current physical activity for health guidelines in older people: a cross-sectional study in Brazilian women. *Archives of Gerontology and Geriatrics, 56*(3), 492-500.

Voorhees, C.C., & Rohm Young, D. (2003). Personal, social, and physical environmental correlates of physical activity levels in urban Latinas. *American Journal of Preventive Medicine, 25*(3 Suppl. 1), 61-68.

Wendel-Vos, W., Droomers, M., Kremers, S., Brug, J., & van Lenthe, F. (2007). Potential environmental determinants of physical activity in adults: a systematic review. *Obesity Reviews, 8*(5), 425-440.

Wilbur, J., Chandler, P.J., Dancy, B., & Lee, H. (2003) Correlates of physical activity in urban Midwestern African-American women. *American Journal of Preventive Medicine, 25*(3 Suppl. 1), 45-52.

Wilcox, S., Bopp, M., Oberrecht, L., Kammermann, S.K., & McElmurray, C.T. (2003). Psychosocial and perceived environmental correlates of physical activity in rural and older african american and white women. *The Journals of Gerontology: Series B Psychological Sciences and Social Sciences, 58*(6), 329-337.

Zizzi, S., Goodrich, D., Wu, Y., Parker, L., Rye, S., Pawar, V., Mangone, C., & Tessaro, I. (2006). Correlates of physical activity in a community sample of older adults in Appalachia. *Journal of Aging and Physical Activity, 14*(4), 423-438.

Zou, Y., Zhang, M., & Maddock, J.E. (2012). Assessing physical activity and related correlates among adults in Hawai'i. *Hawaii Journal of Medicine & Public Health, 71*(11), 310-318.