

The rarity of direct experiences of nature in an urban population

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Highlights

- The most common form of nature experience involves not being present in nature
- Accumulatively 75% of time in nature was experienced by just 32% of the population
- People who experience nature regularly are the exception as opposed to the norm
- Connectedness to nature was positively correlated with spending time in nature
- Deconstructing nature dose will allow the development of targeted health outcomes

1 **Abstract**

2 As people live more urbanised lifestyles there is potential to lose daily contact with nature,
3 diminishing access to the wide range of associated health benefits of interacting with nature.
4 Experiences of nature vary widely across populations, but this variation is poorly understood.
5 We surveyed 1,023 residents of an urban population in the UK to measure four distinctly
6 different nature interactions: indirect (viewing nature through a window at work and at home),
7 incidental (spending time outside at work), intentional (time spent in private gardens) and
8 intentional (time spent in public parks). Scaled-up to the whole study population, accumulation
9 curves of the total number of hours per week that people were exposed to each type of nature
10 interaction showed that 75% of nature interactions were experienced by half the population.
11 Moreover, 75% of the interactions of a type where people were actually present in nature were
12 experienced by just 32% of the population. The average hours each individual experienced
13 nature per week varied across interactions: indirect (46.0 ± 27.3 SD), incidental (6.4 ± 12.7 SD),
14 intentional-gardens (2.5 ± 2.9 SD) and intentional-parks (2.3 ± 2.7 SD). Experiencing nature
15 regularly appears to be the exception rather than the norm, with a person's connection to nature
16 being positively associated with incidental and intentional experiences. This novel study
17 provides baseline information regarding how an urban population experiences different types of
18 nature. Deconstructing nature experience will pave the way for developing recommendations for
19 targeted health outcomes.

20

21 **1. Introduction**

22 With over 70% of the global human population predicted to live in cities within 30 years (WHO,
23 2016a), urbanisation is considered one of the most significant health issues of the 21st century

24 (WHO, 2016b), tied as it is to growing levels of chronic, non-communicable and mental health
25 conditions (Dye, 2008; Sundquist, Frank, & Sundquist, 2004). Urban nature has the potential to
26 help mitigate many of these health issues (Keniger, Gaston, Irvine, & Fuller, 2013; Shanahan et
27 al., 2015b), with demonstrable links between exposure to nature and health and well-being
28 benefits (Hough, 2014; Keniger et al., 2013; Shanahan, Fuller, Bush, Lin, & Gaston, 2015a).
29 These benefits span a remarkable range of health outcomes, with evidence for reduced all-cause
30 mortality and mortality from cardiovascular disease (Donovan et al., 2013; Mitchell & Popham,
31 2008), reduced allergies (Hanski et al., 2012), enhanced general and self-reported health (e.g.
32 Groenewegen, van den Berg, Mass, Verheij, & de Vries, 2012; Maas, Verheij, Groenewegen, de
33 Vries, & Spreeuwenberg, 2006), improved self-reported wellbeing and a reduced risk of poor
34 mental health (e.g. Bratman, Hamilton, & Daily, 2012; Bratman, Hamilton, Hahn, Daily, &
35 Gross, 2015; Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; White, Alcock, Wheeler,
36 & Depledge, 2013) and improved cognitive ability (Berman, Jonides, & Kaplan, 2008; Han,
37 2009).

38

39 Within the urban environment, exposure to nature is more complex and versatile than often
40 portrayed; to a greater or lesser extent many people are exposed to components of nature
41 throughout their daily lives. Keniger et al., (2013) identified three types of nature interactions.
42 First, there is robust evidence for the benefits from ‘indirect interactions’ with nature while not
43 being present in it (e.g. having a view of nature from home or work), including increased
44 psychological well-being (Kaplan, 2001) and reduced stress at work (Kaplan, 1993). Second,
45 people benefit from ‘incidental interactions’ with nature while carrying out another activity (e.g.
46 walking past street trees during daily activities), which can lead to decreased levels of stress

47 (Kaplan, 1993; Lottrup, Grahn, & Stigsdotter, 2013). Third, there is a broad range of benefits
48 provided by ‘intentional interactions’ (e.g. where someone intends to interact with nature through
49 visiting parks or gardens), including reduced mortality from cardiovascular disease (Mitchell &
50 Popham, 2008) and improved mental health (Fuller et al., 2007).

51
52 Plainly, different people receive different levels of each kind of nature experience. This variation
53 likely results from a combination of orientation and opportunity (Lin, Fuller, Bush, Gaston, &
54 Shanahan, 2014; Soga & Gaston, 2015). Some people are more inclined towards interacting with
55 nature (orientation), and some have greater access to those interactions (opportunity). Orientation
56 and opportunity are themselves shaped by a wide array of factors including location, age, gender,
57 ethnicity, income and education, and potentially complex interactions between them (Lin et al.,
58 2014; McCormack, Rock, Toohey, & Hignell, 2010). The net outcome, combined with the
59 composition of an urban population, will determine the extent to which nature interactions are
60 distributed across that population in a more or less equitable fashion (with interactions being
61 roughly equally distributed or disproportionately experienced by a small number of people). To
62 date, this outcome is poorly understood.

63
64 Deconstructing people’s daily nature experience is the first step towards better integrating
65 science with planning and policy for improved health outcomes (Shanahan et al., 2015b).
66 Modelling how, where and what type of nature people experience will allow a clearer
67 understanding of how targeted green planning can be better incorporated into the daily lives of
68 urban dwellers. For example, what kind of environments encourage walking (Middleton, 2010),

69 with the implications for behavioural change, advocacy, design and policy to create better urban
70 environments.

71

72 In an urban population we examine four common nature interactions for which there is tangible
73 evidence for pathways of benefit delivery: indirect interactions (time spent at home and at work
74 in a room with a view of nearby nature); incidental interactions (time spent outside as part of
75 job); intentional interactions (time spent in private gardens) and intentional interactions (time
76 spent in public parks). We explore three questions: 1) How are experiences of nature distributed
77 across different nature interactions? 2) How does this vary across the population? 3) How are
78 these experiences distributed across socio-demographic groups?

79

80 **2. Material and methods**

81 This study was conducted within the urban limits of the ‘Cranfield triangle’ (52°07’N, 0°61’W),
82 a region in southern England, U.K., comprising three adjacent towns of Milton Keynes, Luton
83 and Bedford. These have a human population of c. 609,501 (2011 Census, UK), and occupy 166
84 km². An urban lifestyle survey, delivered online through a market research company (Shape the
85 Future Ltd), was completed in May 2014 by 1,023 adults enrolled in their survey database.

86 Participants were self-selecting and were compensated with a nominal fee. Within the
87 questionnaire, we collected several socio-demographic covariates that could influence nature
88 interactions including age, gender, the primary language spoken at home, personal annual
89 income, highest formal qualification, self-assessment of health and nature orientation (Table S1
90 shows the variables and classifications for analysis purposes).

91

92 Respondents provided self-reported information on four types of common nature interaction that
93 they experience in an average week:

94 (i) *Indirect interactions*: Time spent at home and at work in a room with a view of nearby nature
95 (within 500m; defined as no view, trees, parks, countryside, lake, canal or river). Respondents
96 were asked how many days a week they worked, before selecting how much time they spent in a
97 room with a view of nature at home on an average workday and an average non-workday, and at
98 work on an average working day. In each case respondents selected from the categories: Less
99 than an hour; 1-2 hours; >2-4 hours; >4-6 hours; >6-8 hours; >8-10 hours; >10-12 hours; >12
100 hours. The mid-points of the selected categories were chosen (where 12 or more hours was
101 treated as '12') and then the total time per week was calculated by summing the number of hours
102 on a work day by the number of days worked, and adding the sum of the number of hours on a
103 non-work day by the number of days not worked.

104 (ii) *Incidental interactions*: Time spent working outdoors in an average week. Respondents
105 selected from the categories: No time; 5 hours or less; 6-10 hours; 11-20 hours; 21-30 hours; 31-
106 40 hours; 41-50 hours; 51-60 hours; 61-70 hours; 71 or more hours; Most of the time (in a
107 separate question respondents were asked how many hours they spend at work). The mid-points
108 of selected categories were chosen (where 71 or more hours was treated as '71').

109 (iii) *Intentional interactions (gardens)*: Time spent in private gardens. Respondents selected the
110 total time spent in their private gardens in the last week from the categories; I don't have a
111 garden / no time (these answers were combined, because both responses indicate no experiences
112 of nature in private gardens), 1-30 minutes, 31 minutes to 1 hour, >1-3 hours, >3-5 hours; >5-7
113 hours, >7-9 hours, >9 hours. The mid-points of the selected categories were used for analysis
114 purposes (where 9 or more hours was treated as '9').

115 (iv) *Intentional interactions (parks)*: Time spent in up to seven public parks. Respondents
116 selected from the categories; 1-29 minutes; 30 minutes -1 hour; >1-2 hours, >2-3 hours, >3-4
117 hours, >4 hours. The mid-points of the selected categories were identified (where 4 or more
118 hours was treated as '4') and then the total time was summed across all public parks visited.

119

120 2.1. Statistical analysis

121 We built a generalised linear mixed model with a Gaussian error distribution to model the total
122 time spent experiencing each type of nature interaction (dependent variable), with each
123 respondent as a random effect, against the type of nature interaction, nature orientation, self-
124 assessment of health, age, income, gender, education and ethnicity. We log-transformed the
125 dependent variable so that it was approximately normally distributed, before testing for the
126 effects of covariates and paired interactions (nature interaction*nature orientation, nature
127 interaction*age, nature interaction*income). We used the 'MuMIn' package (Bartoń, 2015) to
128 produce all subsets of models based on the global model and rank them based on AICc.
129 Following Richards (2005) we retained all models where $\Delta AIC_c < 6$. We then used model-
130 averaging to produce the coefficients with standard errors and 95% confidence intervals, of each
131 retained parameter and interaction (Burnham & Anderson, 2002).

132

133 We scaled-up the total hours per week that survey respondents spent experiencing each type of
134 nature interaction to the population of the Cranfield triangle. Based on the proportions indicated
135 by the 2011 Census data we stratified by age (four level factor) to correct the survey population
136 sample to that of the actual population (Appendix S1). We plotted accumulation curves for the
137 total number of hours per week that both the survey respondents and the population of the

138 Cranfield triangle were exposed to each type of nature interaction, and for total time across
139 interactions. We started with respondents who spent the greatest time experiencing nature, and
140 then accumulatively added each respondent to the total population hours in the order of
141 decreasing time spent experiencing nature.

142

143 **3. Results**

144 The average number of hours during which each individual experienced nature per week varied
145 across interactions: indirect (46.0 ± 27.3 SD), incidental (6.4 ± 12.7 SD), intentional-gardens (2.5
146 ± 2.9 SD) and intentional-parks (2.3 ± 2.7 SD; Fig. 1a-d). Across all four nature interactions
147 people spent on average 57.3 ± 31.9 SD hours per week (Fig.1e).

148

149 Accumulation curves were almost identical for survey respondents and when scaled up to the
150 whole population for indirect interactions, which were experienced by the majority of people
151 (Fig. 1a). For other kinds of nature experiences, scaling up led to somewhat slower rates of
152 accumulation than for the survey respondents alone (Fig. 1). A small proportion of the survey
153 population (13%) experienced 75% of the incidental interactions (Fig. 1b). The distribution of
154 intentional experiences was similar for both private gardens and public parks, with 28% and 27%
155 of the survey population, respectively, experiencing 75% of the total time (Fig. 1c and 1d). We
156 found that 75% of all nature interactions were experienced by just 50% of the survey respondents
157 and of the population.

158

159 Experiences of indirect and intentional (in gardens) interactions increased with age, while people
160 over 60 had more intentional interactions in parks (Table 1). Respondents who experienced all

161 four types of nature interaction had better self-reported health (Table 1), while those who
162 incidentally and intentionally interacted with nature had a higher nature orientation than those
163 experiencing it indirectly (Table 1). Gender, education and ethnicity were not important
164 predictors of time spent experiencing nature.

165

166 **4. Discussion**

167 We demonstrate that, across four common types of nature interaction, accumulatively 75% of
168 nature experiences were experienced by just 50% of the population. However, accumulatively
169 75% of interactions where people were actually present in nature were experienced by just 32%
170 of the population. Indeed, people who directly experience nature regularly in any given week are
171 clearly the exception rather than the norm. This novel study provides baseline information
172 regarding how experiences of nature vary across an urban population. This is a first step towards
173 linking urban design and policy towards maximising the health benefits from urban nature.

174

175 4.1. Indirect interactions

176 For the majority of people, the most common method of experiencing nature is while not actually
177 being present in it, but by viewing natural scenes through a window.

178 Importantly, having a room with a view of nature does not necessarily mean that people are
179 continuously experiencing that view. Instead, at work and in the home most people spend a
180 significant amount of time with their attention directed towards specific tasks, and the presence
181 of a window with a natural scene allows micro-restorative experiences (Kaplan, 1993, 2001),
182 with scenes that are more fascinating being likely to be more restorative (Kaplan & Kaplan,
183 1989). Here we show that there is great variation in the type of nature people can see from their

184 windows and this varies between work and home (Fig. S1). We show that street and residential
185 trees are providing the lion's share of indirect nature experiences. An important contribution of
186 future research would be to unpick how trees are distributed across the landscape in relation to
187 the flow of people experiencing them. This would allow architects and planners to exploit key
188 areas where the greatest number of people would interact with trees.

189

190 Despite research showing the benefits of nature views, such as office workers having perceived
191 lower levels of job stress and higher job satisfaction (Kaplan & Kaplan, 1989), and residents of
192 greener neighbourhoods reporting increased neighbourhood satisfaction and well-being (e.g.
193 Kaplan, 2001), a significant number of people in this study had no good view of nature at work
194 (33.8%) or at home (18.1%; Fig. S1). Neither nature orientation, age nor income were significant
195 predictors of indirect interactions with nature, suggesting these experiences are more a
196 consequence of opportunity, rather than orientation towards nature (i.e. you either live or work in
197 a room with a view of nature, or you do not). Considering the benefits that visual access to nature
198 provides there is considerable significant potential through innovative urban greening to further
199 increase people's indirect exposure.

200

201 4.2. Incidental interactions

202 Half of all workers spent some time outside at work, although the steep accumulation curve
203 shows that a large proportion of people spend most of their work hours outdoors, rather than
204 many people spending a small proportion of time outdoors. Nature orientation showed a
205 significant positive relationship with incidental time spent in nature, suggesting that either people
206 with an increased orientation towards nature are more likely to choose jobs where they spend

207 time outside, and/or that daily nature experiences increase nature orientation (Soga & Gaston,
208 2015). A large proportion of the population spends a substantial amount of time in the
209 workplace. Short work breaks are a common part of office culture and offer an important and
210 largely untapped opportunity to promote healthy contact with nature. Indeed, attention
211 restoration and self-esteem have been found to increase in as little as five minutes spent outside
212 (Barton & Pretty, 2010), suggesting that access to nature at work can promote significant gains
213 towards improving office health and productivity (Largo-Wight, Chen, Dodd, & Weiler, 2011).

214
215 Further research needs to explore daily incidental experiences of nature as people travel around
216 the landscape. Unfortunately, this is not easily done and requires rather different approaches that
217 are likely to be challenging to extrapolate to the entire population in the way that was done in
218 this study. In future studies it will be important to unpick these experiences and the relative
219 health benefits they provide, both from the nature people interact with, and how this varies
220 across different activities people are engaged in during these interactions.

221
222 4.3. Intentional interactions

223 Private gardens provide an immediate and readily accessible way for people to experience
224 nature. Considering that 92% of the survey respondents claimed access to a private green space,
225 it is somewhat surprising that 75% of the time spent in gardens was experienced by merely 28%
226 of the population. Clearly opportunity was not the driving force behind use, instead we found
227 orientation to be a strong predictor. Such results are supported by previous research showing that
228 people with a higher orientation towards nature have the potential to receive high levels of
229 garden vegetation benefits through active and passive means (Lin, Gaston, Fuller, Wu, Bush, &

230 Shanahan, 2017), and spend more time in private gardens and public parks, while living in areas
231 with more vegetation (Lin et al., 2014). Literature from the environmental psychology field also
232 shows that appreciation of nature is a significant motivation for people to spend time in nature
233 (Clayton, 2007).

234

235 The ten-fold increase in hours spent in private gardens over public parks probably reflects
236 differences in ease of access and the fundamentally different roles that they play in people's
237 lives. Time spent in parks increased with income possibly because wealthier neighbourhoods
238 often have increased access to higher quality green space encouraging use (Shanahan, Lin,
239 Gaston, Bush & Fuller, 2014; Soga, Yamaura, Aikoh, Shoji, Kubo, & Gaston, 2015). We did not
240 find that income affected time in gardens, which supports the results of previous studies (Lin et
241 al., 2017). We did find that both time in parks and in gardens increased with age, probably
242 because people's relationship to nature changes as they get older (Shanahan et al., 2017) or
243 simply because older people have more leisure time (Gauthier & Smeeding, 2003).

244

245 **5. Conclusions**

246 Within an urban population variation in daily nature experiences is driven by both opportunity
247 and orientation. To reverse the trend of declining nature experiences, research and public policy
248 need to address both of these components. Arguably the simplest approach is to increase the
249 quantity of green infrastructure (Shanahan et al., 2015b; Soga et al., 2015), thereby increasing
250 both indirect and incidental interactions. However, as shown here and by Lin et al. (2014)
251 opportunity is not sufficient to encourage use. It is critical to design public health interventions
252 that increase people's orientation toward nature. Both theory and evidence suggest that

253 orientation is influenced by regular outdoor play during childhood (Bixler, Floyd, & Hammitt,
254 2002; Thompson, Aspinall, & Montarzino, 2008). However, there is also enormous scope to
255 increase orientation in adults through participation in nature-based activities (Scott, Amel, &
256 Manning, 2014). Those who do not interact with nature may lose the substantial benefits
257 associated with health and well-being (Keniger et al., 2013; Shanahan et al., 2015a). The health
258 and well-being benefits of experiencing nature are now well established. The challenge is
259 encouraging a greater proportion of the population to engage with the natural world around them.
260 However, care needs to be taken, as a rise in the number of people accessing green spaces for
261 health benefits might threaten urban ecosystems and the very health benefits that people seek
262 (Stanley et al., 2015). Deconstructing types of nature experiences, as done here, is critical for
263 guiding recommendations and policy to ensure that across the population the most people can
264 benefit from interactions with nature.

265

266 **Data accessibility**

267 Due to third party restrictions, the data are available on request from the corresponding author.
268 The dataset will be available from the NERC Environmental Data Information Centre from mid
269 2017.

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Table 1: The relationship between the total time spent experiencing each type of nature interaction (log-transformed) for each respondent and covariates. Respondent is a random effect, and model averaged parameter estimates and confidence intervals are given for factor levels relative to a comparative base factor level (Health, very poor; Nature interaction type, Indirect). Significant variables and factor levels are shown as $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

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Variable	Estimate (SE)	95% Confidence intervals
Intercept	1.97 (0.3)***	1.39; 2.55
Income	0.06 (0.03)	-0.01; 0.12
Nature orientation	0.09 (0.9)	-0.09; 0.27
Age	0.00 (0.01)	-0.02; 0.03
Ethnicity	0.04 (0.04)	-0.05; 0.12
<i>Health</i>		
Poor	0.04 (0.11)	-0.18; 0.26
Average	0.22 (0.10)*	0.02; 0.42
Good	0.24 (0.10)*	0.05; 0.44
Very good	0.28 (0.10)**	0.08; 0.48
<i>Nature interaction</i>		
Incidental	-2.14 (0.33)***	-2.79; -1.50
Intentional (garden)	-2.65 (0.44)***	-3.51; -1.79
Intentional (park)	-2.78 (0.42)***	-3.60; -1.95
<i>Nature orientation: Nature interaction</i>		
Nature orientation: Incidental	0.18 (0.08)*	0.01; 0.34
Nature orientation: Intentional (garden)	0.33 (0.09)***	0.16; 0.50
Nature orientation: Intentional (park)	0.31 (0.08)***	0.15; 0.48
<i>Age: Nature interaction</i>		
Age: Incidental	0.00 (0.02)	-0.03; 0.03
Age: Intentional (garden)	0.07 (0.02)***	0.04; 0.10
Age: Intentional (park)	0.04 (0.02)*	0.01; 0.07
<i>Income: Nature interaction</i>		
Income: Incidental	0.15 (0.04)***	0.07; 0.24
Income: Intentional (garden)	-0.05 (0.04)	-0.13; 0.04
Income: Intentional (park)	0.09 (0.04)*	0.01; 0.18
Conditional R ²	0.42	

List of figures

Figure 1. Cumulative hours spent per week experiencing different nature interactions by survey respondents (left y axis; solid curve) and scaled up to the whole population of the Cranfield triangle (right y axis; dashed curve): a) indirect interactions (in a room with a view of nearby nature); b) incidental interactions (working outside); c) intentional interactions (private gardens); d) intentional interactions (public parks); e) the total time across interactions. We show the percentage of the population that account for 25% (dotted line), 50% (dashed line), 75% (dash/dot line) and 100% (solid line) of the total nature experienced.

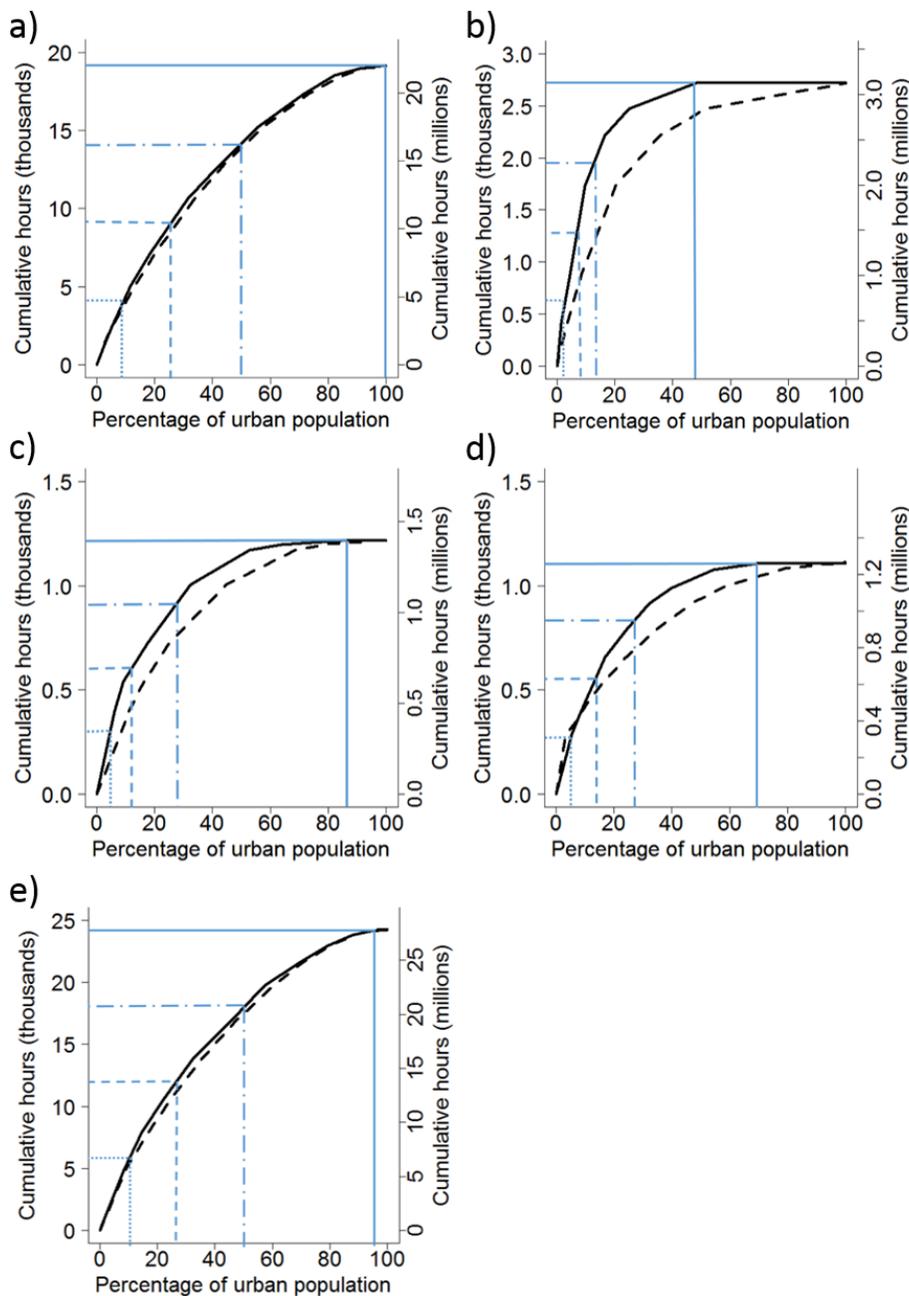


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Ethical clearance

This research was conducted with approval from the Bioscience ethics committee of the University of Exeter (project number 2013/319). Participants provided written consent at the beginning of the online survey.

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