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Children's physical activity and psychological health: the relevance of intensity

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Abstract

Aim: To examine the relevance of physical activity intensity when assessing the relationship between activity and psychological health in 9–10-year-old children.

Methods: Activity was assessed by accelerometry in 57 boys (n = 23) and girls (n = 34). Total activity and time spent in very light (≤1.9 METs) through to vigorous activity (≥6 METs) were recorded. Psychological health inventories to assess anxiety, depression and aspects of self-worth were completed.

Results: Time accumulated in very light activity had positive correlations with anxiety and depression ($r > 0.30$, $p < 0.05$) and negative correlations with aspects of physical self-worth ($r > -0.29$, $p < 0.05$). Time accumulated in vigorous activity had negative correlations with anxiety and behavioural conduct ($r > -0.30$, $p < 0.05$) and positive correlation with aspects of physical self-worth ($r > 0.28$, $p < 0.05$). Children spending over 4 h in very light intensity activity had more negative psychological profiles than children spending under 4 h at this intensity.

Conclusion: Aspects of psychological health were negatively correlated with very light intensity activity and positively correlated with vigorous intensity activity. Further research should investigate whether reducing time spent in very light intensity activity and increasing time spent in vigorous intensity activity improves psychological health in children.

INTRODUCTION

The prevalence of psychological problems in children and adolescents is reported to be between 10 and 20% (1), with anxiety and depression being the two most common disorders (2). Physical activity can reduce depression and anxiety in adults (for a critical review see Ref. (3)). However, the evidence is not as clear for children (4) although exercise intervention studies have shown trends for small beneficial effects, regardless of exercise intensity (4). Potential mechanisms that could account for these effects include exercise-induced stimulation of brain monoamine (5), neurotrophins (6) or improved self-esteem, which has been shown to be predictive of depression risk in obese adolescents (7).

It has been argued that to fully reflect psychological health, the absence of negative psychological states (e.g. anxiety and depression) and the presence of positive states (e.g. self-esteem) need to be considered (8). Further, self-esteem as a predominant component of psychological health (9,10) is itself a multidimensional construct (11,12) which needs to be explored further to enhance the understanding of psychological health and the relationship with physical activity (10,13). Harter (11) proposed five esteem domains for children 8 years old and over. These are scholastic competence, athletic competence, social acceptance, physical appearance and behavioural conduct, which are correlated and predictive of global self-worth (esteem). Each domain is conceptualized to have a number of sub-domains. Fox and Corbin (12) and Whitehead (14) have identified four sub-domains to the domain of physical self-worth, with the athletic competence domain assuming a sub-domain position in their hierarchical models. These sub-domains are sports/athletic competence, physical condition/stamina, body attractiveness and physical strength (12,14). Physical self-worth has been shown to mediate the relationships between global self-worth and measures at the sub-domain level (14).

Research relying on exercise class attendance and subjective recall methods as a measure of physical activity has shown that the sub-domains of physical self-worth are correlated with physical activity in adults (15) and children (16,17). However, these methods have limited utility in children where objective measures are recommended (18). Research has shown (19) both pedometers and accelerometers to be reliable and valid tools for the measurement of physical activity in children, with the accelerometer being the single best measure of activity levels in children. Further, uniaxial and triaxial accelerometers facilitate temporal tracking of the frequency, intensity and duration of activity (19).

Parfitt and Eston (10) utilizing pedometers to investigate the relationship between children's habitual activity levels (total daily steps) and psychological health reported a strong positive correlation with global self-worth, and negative correlations with depression and anxiety. After accounting for each of the other two variables, in order to explore unique relationships with total daily steps, the correlation only remained significant for self-worth.

There were limitations in the above study, the psychological health measure only considered global self-worth and did not include the assessment of the domains of self-worth or the sub-domains of physical self-worth. A recent study by Raustorp et al. (20) found weak to moderate associations between the sub-domains of physical self-worth and physical activity steps per day in 11–12-year-old children. Only total steps were measured, and to date only self-reported moderate-vigorous physical activity (MVPA) has been considered (17). However, there were positive associations between MVPA and physical self-worth domains, therefore it would seem prudent to analyse associations at differing intensities of activity.

This cross-sectional study aims to address the limitations of the earlier studies. The measure of self-worth was expanded to incorporate a more complete assessment of global self-worth, the esteem domains and the four sub-domains of physical self-worth. Exploration at the sub-domain level of physical self-worth may identify specific relationships with physical activity and highlight aspects (e.g. specific intensities vs total activity) to target at an intervention level. Accelerometry was used to assess physical activity over two time points to obtain a measure of total physical activity and activity intensity that accounted for seasonal variation (21). Further, the influence of body fatness as a potential confounder was addressed, as it is related to both psychological health (22) and physical activity (18).

It is hypothesized that physical activity (including vigorous intensity activity) is positively correlated with global self-worth, physical self-worth and the subsequent sub-domains of physical self-worth and that anxiety and depression are negatively correlated with physical activity. Participants who spend more time in high intensity activity and/or less time in very light activity will have more positive psychological profiles.

METHODS

Participants

The School's Ethics Committee granted approval for this study. Participants were 82 children (32 boys and 50 girls), aged 9–10 years, from three primary schools in the South West of England during 2006–2007.

General procedures

There were approximately 30–60 children across the year group in each school providing a maximum sample of 120 children. Information letters outlining the study were sent home with the children, along with written informed consent forms. A total of 82 consent forms, signed by a parent and the child participant, were returned. The researchers have no details on the 38 children who chose not to participate. All data were collected during the school semester/term.

Data collection procedures

Height, mass and body fatness, via bioelectrical impedance analysis, were measured at baseline. Each child was then given an accelerometer and shown how to wear it. The accelerometers were worn by the children for two seven-day periods (one during the spring and one during the fall/autumn). After each seven-day period, the researcher collected the accelerometers. Following the second seven-day period (fall/autumn), the children completed three psychological well-being inventories to assess anxiety, depression, global self-worth and the various domain and sub-domain measures.

Anthropometric data

Height was measured to the nearest 0.1 cm using a free-standing Seca stadiometer (Seca AG, Reinach, Switzerland). Leg-to-leg impedance and body mass (to the nearest 0.1 kg) were measured simultaneously by the Tanita TBF-305 body composition scales (Tanita U.K. Ltd., Middlesex, U.K.) and the prediction of percent body fat was recorded.

Assessment of psychological health

Three questionnaires were used to assess the children's psychological well-being. The State-Trait Anxiety Inventory for Children (STAIC: (23)), the Child Depression Inventory (CDI: (24)) and a combination of the Self-Perception Profile for Children (SPPC: (12)) and the Children and Youth's Physical Self-Perception Profile (CY-PSPP: (14)). These inventories all provide trait measures of the constructs being assessed. During data collection, the researcher was present to answer any questions the children had about the questionnaires.

The STAIC assesses both state and trait anxiety in children. As the research question was concerned with the chronic relationship between physical activity and psychological well-being, only items for the trait scale were completed. Published alpha coefficients for children show good ranges, from 0.78 to 0.81 (23) and 0.89 in the current study. Test–retest reliability of the trait scale has shown moderate coefficient ranges of 0.65 to 0.71 (23).

The CDI is composed of 27 items. One item (item 9, the suicide ideation item) was removed from the inventory, as it was deemed unnecessary, thereby reducing the range of scoring to 0–52. This is recognized as an acceptable procedure (24). Higher scores represent less favourable levels of depression. Good reliability data for children has been observed, 0.83 to 0.89 (25) (0.9 in the current study) with adequate test–retest reliability, 0.74 to 0.77 (25).

In order to get a more robust understanding and measure of the children's self-perception, the SPPC was amalgamated with the CY-PSPP. The SPPC contains six scales, item scores range from 1–4, with scale scores ranging from 6 to 24. Higher scores reflect more positive perceptions. Adequate Cronbach's alpha has been shown across the subscales, ranging from 0.71 to 0.86 (11) and 0.8 to 0.9 in the current study. The CY-PSPP, developed from Harter (11) and Fox and Corbin's (12) physical self-perception profile, contains six subscales with scores ranging from 6 to 24. The items for global self-worth and sport/athletic competence are included in both scales and were removed from the SPPC, reducing the SPPC to 4 scales. The CY-PSPP has good

alpha reliability, ranging from 0.77 to 0.91 (26) (0.86 to 0.91 in the current study), and high factorial and predictive validity with young children (8 year olds) (14). The combined scales provide an assessment of global self-esteem, assessment of domain level constructs (scholastic competence, social acceptance, behavioural conduct, physical appearance, physical self-worth) and sub-domain constructs of physical self-worth (sport/athletic competence, condition/stamina competence, attractive body competence, strength competence).

Assessment of physical activity

Each child wore an RT3 triaxial accelerometer (Stayhealthy Inc., Monrovia, CA, USA) on the hip (approximately midline to the thigh) from getting up in the morning to when s/he went to bed at night for up to seven days at each data-collection point. The children were instructed to keep the accelerometer in the attachment clip to minimize the risk of data loss due to the opening of the battery compartment. The RT3 accelerometer measures activity in three dimensions, providing a composite output measure (vector magnitude). Size and mass (including battery) of the RT3 are 7.1 × 5.6 × 2.8 cm, 65.2 g. The epoch interval was set at 1 min. The RT3 has been found to be a reliable and valid (27) tool for the assessment of activity, for both adults and children.

Based on reviews of accelerometer use for the assessment of physical activity (28) at least four days of data, including at least one weekend day, needed to be recorded for each data-collection point. It took four weeks in total to collect data for each seven-day period. Weather and daylight hours were consistent across these seven-day periods. For the current sample, mean days of recorded data for spring and autumn were 5.7 (±0.56) and 5.4 (±0.74), respectively. To be classified as a day, a weekday needed to have at least 10 h of data, with a weekend day needing at least 8 h of data. The mean of the two physical activity data-collection periods were used for all measured variables in order to account for seasonal variations in physical activity (21). To provide intensity levels, minute-by-minute epochs were converted into METs ((27): see Table 1), with average daily accumulated minutes at each activity intensity recorded.

Data analysis

Descriptive data (mean and SD) were calculated for age, anthropometric measures, accelerometer counts and minutes spent at each intensity level. Independent *t*-tests were performed to identify any sex differences across the descriptive data variables. Following the *t*-tests (showing no difference between boys and girls for total activity and psychological variables), and scrutiny of scatter plots (to confirm relationships were similar across sex), data for the boys and girls were collapsed and Pearson Product Moment Correlation Coefficients (*r*) were used to assess the relationships between the psychological health constructs and recorded physical activity/intensity. This was followed by partial correlations for any significant zero-order correlations, to explore relationships after controlling for percent body fat.

To explore the quantity of activity associated with more positive psychological health profiles, sex specific tertile groups for habitual physical activity and physical activity intensity were created. A sex (2) X-activity level (3) multivariate analysis of variance (MANOVA) was carried out for each activity intensity level, where significant correlations were present with psychological health after controlling for percent body fat. In line with the theorized hierarchy, the multivariate variables were anxiety, depression and global self-worth in the first set of analyses, the domains of self-worth in the second set of analyses and the sub-domains of physical self-worth in the final set. Univariate analyses were used to follow up significant effects. All data analyses were performed using the SPSS (version 15.0; SPSS Inc., Chicago, IL, USA) statistical package, with alpha set 0.05.

Table 1 Intensity level conversion table for RT3 accelerometer data

Intensity	Accelerometer counts/min	METs equivalent	Sample activity (29)
Very light	100.0–470.1	up to 1.9 METs	Seated to standing (minimal movements)
Light	470.1–976.8	1.9–3 METs	Playing catch
Moderate	976.8–2337.2	3–6 METs	Walking
Vigorous	>2337.2	>6 METs	Running

RESULTS

A total of 57 participants (23 boys, 34 girls) provided adequate data for analysis. Descriptive data (means and standard deviations) for the children are presented in Table 2. Girls accumulated significantly more minutes in light intensity activity ($t_{55} = 2.678$, $p < 0.01$) and significantly fewer minutes in vigorous intensity activity ($t_{55} = 2.218$, $p < 0.05$) than boys. No further sex differences were present.

Correlation analyses were used to investigate the relationship between overall physical activity (accelerometer counts) and each measure of psychological well-being (anxiety, depression and global, domain and sub-domain self-worth variables). As indicated in Table 3, there were no

Table 2 Descriptive data for boys and girls

	Boys		Girls	
	Mean	SD	Mean	SD
Age (yr)	10.1	0.3	0.1	0.3
Height (cm)	144.3	5.8	43.0	7.1
Mass (kg)	37.9	8.2	7.6	7.8
Body fat (%)	16.5	7.9	19.1	8.9
Total daily counts	378972.0	57062.7	364388.3	70572.3
Intensity:				
Very light (mins)	224.4	32.2	231.2	27.0
Light (mins)	107.9[a]	18.0	120.0[a]	15.6
Moderate (mins)	87.1	14.7	87.6	17.1
Vigorous (mins)	34.6[a]	13.8	27.0[a]	11.9

[a] Significant sex difference.

Table 3 Correlation analyses for overall physical activity and physical activity intensities with psychological health variables (N = 57)

	Overall activity		Very light		Light		Moderate		Vigorous	
	r	r_{fat}	*r*	r_{fat}	*r*	r_{fat}	*r*	r_{fat}	*r*	r_{fat}
Anxiety	−0.195		0.384**	0.331*	0.173		−0.110		−0.310**	−0.283*
Depression	−0.014		0.345**	0.282*	0.202		0.103		−0.177	
Global self-worth	−0.032		−0.400**	−0.295*	−0.345*	−0.212	−0.132		0.121	
Scholastic competence	0.081		−0.341**	−0.286*	−0.225		−0.119		0.281*	0.253
Social acceptance	0.248		−0.118		0.002		0.018		0.338**	0.309*
Behavioural conduct	−0.359**	−0.362**	−0.067		−0.229		−0.315*	−0.289*	−0.273*	−0.326*
Physical appearance	−0.050		−0.385**	−0.282*	−0.345*	–0.218	−0.132		0.121	
Physical self-worth	−0.055		−0.388**	−0.266*	−0.301*	−0.152	−0.139		0.115	
Sport/athletic competence	0.242		−0.133		−0.056		0.090		0.335*	0.300*
Condition/stamina comp	0.258*	0.300*	−0.184		−0.053		0.122		0.324*	0.285*
Attractive body comp	−0.103		−0.297*	−0.162	−0.297*	−0.156	−0.188		0.066	
Strength competence	0.025		−0.085		−0.103		0.039		0.066	

r = zero order correlation; r_{fat} = correlation with body fat partialled out (conducted when zero order correlation was significant).
*p < 0.05, **p < 0.01.

significant relationships between accelerometer counts and anxiety or depression. Behavioural conduct had a negative association with overall physical activity and condition/stamina had a positive correlation.

Correlation analyses were also used to investigate the relationship between physical activity intensity and each measure of well-being. As indicated in Table 3, very light activity was positively correlated with measures of anxiety and depression and negatively correlated with measures of global self-worth, scholastic competence, physical appearance, physical self-worth and attractive body competence. Light intensity activity was negatively correlated with global self-worth, physical appearance, physical self-worth and attractive body competence, and moderate intensity activity was negatively correlated with behavioural conduct. Finally, vigorous intensity activities were negatively correlated with anxiety and positively correlated with measures of scholastic competence, social acceptance, athletic competence and condition/stamina competence.

After controlling for body fat, light intensity activity was no longer correlated with any psychological variables. In addition, the correlations of very light intensity activity with attractive body and vigorous intensity activity with scholastic competence were no longer significant. All other significant correlations remained.

Based on the results of the correlations after controlling for body fat, MANOVA were conducted at the very light and vigorous physical activity intensities (Table 4). The MANOVAs conducted on the very light activity intensity groups resulted in significant activity level main effects for the first (anxiety, depression and global self-worth) set (Wilks' Lambda = 0.693, $F_{6,98} = 3.28$, $p < 0.01$, $\eta^2 = 0.11$) and second (scholastic, social, behavioural conduct, appearance and physical self-worth) set (Wilks' Lambda = 0.619, $F_{10,94} = 2.54$, $p < 0.01$, $\eta^2 = 0.12$) of variables. Univariate follow-up tests indicated that anxiety and global self-worth accounted for the first effect with the middle amount of very light intensity activity group recording significantly lower anxiety scores ($F_{2,51} = 4.8$, $p < 0.01$, $\eta^2 = 0.16$) and higher global self-worth scores ($F_{2,51} = 5.9$, $p < 0.01$, $\eta^2 = 0.18$) than the high amount of very light intensity activity group, although the middle group did not differ from the group with the lowest amount of very light activity; appearance and physical self-worth accounted for the second significant main effect, with the middle amount of very light intensity activity group different to the high amount of very light intensity activity group ($F_{2,51} = 6.73$, $p < 0.01$, $\eta^2 = 0.24$), and $F_{2,51} = 6.3$, $p < 0.01$, $\eta^2 = 0.21$, respectively). As before, the middle group did not differ from the group accumulating the lowest amount of very light activity. No significant effects were recorded for vigorous intensity activity.

DISCUSSION

The results support the hypothesis that time accumulated at different intensities of physical activity is associated with children's psychological health. This extends previous cross-sectional research concerning the relationship between total habitual physical activity and psychological health in children, using a mechanical measure of physical activity (10). It has been demonstrated that children accumulating high levels of very light activity report higher levels of anxiety and depression and lower levels of global self-worth, while children accumulating high levels of vigorous activity report lower levels of anxiety and higher levels of global self-worth. These relationships persisted after controlling for body fatness. This represents the first investigation into the relationship between children's psychological health and time accumulated at different activity intensities that utilizes an objective measurement of physical activity intensity.

Contrary to previous literature (16) the relationships between overall habitual physical activity physical self-worth and its sub-domains were not strong. Unlike Parfitt and Eston (10), there were no correlations between overall

Table 4 Means and standard deviations for the psychological health variables in each tertile group for the significant MANOVA

Psychological health	Very light activity			Vigorous activity		
	Low group	Middle group	High group	Low group	Middle group	High group
Boys	191 ± 25 min	216 ± 23 min	261 ± 23 min	21 ± 14 min	31 ± 13 min	49 ± 13 min
Girls	202 ± 20 min	228 ± 19 min	262 ± 20 min	15 ± 8 min	25 ± 8 min	41 ± 8 min
MANOVA 1: anxiety	30.5 (1.7)	28.8[a] (1.6)	35.7[a] (1.6)	35.7 (1.6)	29.9 (1.6)	29.8 (1.6)
Depression	8.3 (1.9)	7.1 (1.8)	11.2 (1.9)	10.6 (1.9)	9.3 (1.9)	6.8 (1.0)
GSW	18.9 (0.8)	20.6[a] (0.8)	16.6[a] (0.8)	17.6 (0.9)	19.2 (0.9)	19.4 (0.9)
MANOVA 2: scholastic	18.2 (0.9)	16.4 (0.9)	15.9 (0.9)	16.2 (0.9)	15.9 (0.9)	18.2 (0.9)
Social	18.3 (1.1)	19.1 (1.0)	18.5 (1.1)	16.9 (1.0)	18.1 (1.0)	20.8 (1.0)
Behavioural	17.5 (0.8)	18.0 (0.8)	17.1 (0.8)	18.2 (0.8)	18.1 (0.8)	16.4 (0.8)
Appearance	17.5 (1.0)	20.2[a] (1.0)	14.2[a] (1.0)	15.4 (1.0)	18.7 (1.0)	17.4 (1.1)
PSW	18.0 (1.0)	20.2[a] (0.9)	15.0[a] (1.0)	16.7 (1.1)	18.5 (1.1)	18.0 (1.0)
MANOVA 3: athletic	17.5 (1.1)	18.6 (1.0)	16.5 (1.1)	15.7 (1.1)	18.0 (1.0)	18.8 (1.0)
Stamina	19.1 (0.9)	19.9 (0.8)	17.6 (0.9)	17.1 (0.9)	19.8 (0.8)	19.6 (0.9)
Attractive	16.3 (1.0)	19.1 (1.0)	14.5 (1.0)	15.6 (1.1)	17.6 (1.0)	16.6 (1.1)
Strength	16.1 (1.0)	17.0 (1.0)	16.4 (1.0)	16.6 (1.0)	17.0 (1.0)	15.9 (1.0)

[a]Groups significantly different ($p < 0.01$); GSW = global self-worth; PSW = physical self-worth.

physical activity and global self-worth. The weak positive correlation with condition/stamina is in line with Raustorp et al. (20) and Crocker et al. (16), and supports the argument that children who are generally more active perceive that they have higher levels of the condition/stamina domain.

The relationship identified between activity intensity and psychological health suggests that the opposing ends of the intensity spectrum may play a vital role in the relationship with psychological health. Total time accumulated in very light intensity activity had positive correlations with both anxiety and depression, and negative correlations with global self-worth, physical self-worth and other domains. Time spent in vigorous intensity activity was negatively correlated with anxiety and positively correlated with in particular, sub-domains of physical self-worth. Although these data are unique in objectively measuring the different intensities, they do lend some support to Raudsepp et al. (17) who showed that physical self-worth domains were positively correlated with moderate to vigorous physical activity using a seven-day physical activity recall questionnaire.

Controlling for the potentially confounding influence of body fatness removed any significant correlations with the attractive body construct. This is not that surprising due to the documented associations between body dissatisfaction and fatness (22). Further, significant correlations still remained at the very light and vigorous intensities for several aspects of psychological health, notably anxiety, which was related to both ends of the intensity spectrum. This suggests time spent in running activities and low levels of time spent in 'some but minimal movement' may be of importance for psychological health, regardless of the influence of body fat.

However, given the current findings from the tertile group analyses, this is not as simple as decreasing the amount of time in very light activity and promoting time in vigorous activity. Children in the middle tertile group of very light activity had a more positive psychological profile than those spending a little time in very light activity. Further, the absolute scores on the psychological health variables of this middle group were commensurate with the scores recorded by individuals who spent a high amount of time in vigorous activity. Potentially, it is the pattern of the amount of time in each intensity, which is important. The children in this middle group were perhaps balancing the amount of time in each intensity to confer positive benefits. A consideration of the tertile group allocation would support this, with 85% of children in this group in the middle and high tertile group of moderate and vigorous intensity activity, whereas, only 59% of children in the high tertile group (those who spent the most amount of time in very light activity) were in these middle and high tertile groups of moderate and vigorous activity.

One theory, which may explain this patterning, is the behavioural choice theory (29). For many children there are attractive sedentary and very light intensity alternatives to physical activity (e.g. television viewing, computer games). However, it is suggested that youth sedentary behaviours are complex and unlikely to be represented by one behaviour. Indeed, television viewing and physical activity are un-associated and separate constructs (30). Through the use of cluster sub-groups Gorely et al. (30) established that active adolescents spend more time outside. Being inside may restrict physical activity and provide more opportunities to engage in sedentary or very light intensity behaviours. The tertile analysis of the current study has provided a form of clustering and it is suggested that understanding why children and adolescents in less active clusters have these behaviours may be important in the facilitation of more active lifestyles (30).

Given the current findings from the tertile group analyses, data for the anxiety, global self-worth, physical self-worth and various sub-domains suggest that up to 4 h in very light intensity activity along with 30 min or more in vigorous

intensity activity are associated with the most positive psychological profiles. This study was cross-sectional in nature and research is needed to establish the causal direction of this relationship. Based on the available evidence, and as previous intervention research has indicated, physical activity has positive effects on psychological health constructs (9) children spending more than 4 h each day in very light activity should be encouraged to reduce this time by increasing the amount of time in more intense activity. A reduction of around 40 min a day of very light intensity activity which is displaced to higher intensity activities may help to improve the psychological health profiles for children of this age group. The valence of this suggestion could be addressed with research that focuses on reducing overall time in very light intensity activity.

In contrast to some previous literature (18), but not all (10), there is no suggestion that total activity was greater in boys than girls in this sample. However, as reported by Raudsepp et al. (17) boys did spend significantly more time in vigorous intensity activities than girls. The girls spent significantly more time in light intensity activities. It is noted that all children averaged over 60 min of moderate intensity activity daily, meeting the current physical activity guidelines (31).

On a cautionary note, the population in the study was small and the data may not be representative of all 9–10-year-old children. In addition, the effect of reduced hours of daylight could influence both the time spent in different intensities of activity as well psychological health generally. However, data were collected over a time period with consistent hours of daylight. Future research could pursue these areas.

CONCLUSIONS

Psychological well-being was correlated with time accumulated at vigorous and very light physical activity intensities. Specifically, children who accumulated less than 4 h of very light intensity activity had more positive psychological health profiles than children who accumulated more than 4 h. Results indicate that the balance of time spent at high and low intensities may be more important than absolute time spent at each. Although this study was cross-sectional in nature, previous intervention research has highlighted the positive effects of physical activity on psychological health constructs (9). The promotion of a balanced physical activity profile focusing on reducing time in very light activity and increasing time in higher intensity activities may improve psychological health for this age group. Ongoing longitudinal research may help to clarify the nature of the optimal balance of activity and the causal direction of the relationships identified.

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