

PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR IN 12-13 YEAR OLD CHILDREN, STRATIFIED BY SEX, SCHOOL TYPE AND RESIDENTIAL DEPRIVATION SCORE

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How to cite this article: Davies, E.J. Greenfield, J.R.F., & Edwards, K.L. (September, 2016). Physical activity and sedentary behaviour in 12-13 year old children, stratified by sex, school type and residential deprivation score. Journal of Physical Education Research, Volume 3, Issue III, 13-28.

Received: July 6, 2016

Accepted: September 23, 2016

ABSTRACT

Many children are insufficiently active for good health. Factors affecting childhood physical activity and sedentary behaviour levels have been identified, including residential and school factors. Three schools in Sheffield, UK were recruited. Data were collected from children aged 12-13 years on their physical activity and sedentary behaviours using the Youth Physical Activity Questionnaire. Data were analysed using univariate (t-test), non-parametric (X^2 , Kruskal Wallis), and regression models adjusted for school type, sex and residential deprivation score. Children (n=189) attending the independent schools had higher MVPA levels ($p<0.008$; 95% CI 348-2289 extra minutes per week), and were more likely to meet the physical activity guidelines; this association was particularly strong for boys (boys at independent schools 7.8x more likely). Sex and residential deprivation score were not statistically significantly associated with MVPA or meeting physical activity guidelines. Children in affluent areas had the highest sedentary behaviour levels ($p=0.021$; 95% CI -1171 to -98). School type and sex were not statistically significantly associated with sedentary behaviour, after adjusting for the other factors. This study found that independent school children, particularly boys, were more active across the whole day, when compared with their state school counterparts. They were also more likely to meet the government's physical activity guidelines. There was no significant difference in the amount of time girls and boys spent in sedentary activities, but the types of sedentary activity differed between sexes. Children from less deprived areas reported more time spent in sedentary activities.

Keywords: Exercise, sedentary, guidelines and recommendations, paediatrics, policy, youth.

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1. INTRODUCTION

We know that being insufficiently active is bad for health. Childhood inactivity is associated with obesity, increased mental health problems, decreased cognition, increased cardiovascular risk factors, type 2 diabetes, poor bone health (Department of Health, 2004) and decreased adult physical activity levels (Kjonniksen, Fjortoft, & Wold, 2009). The first physical activity guidelines for children in the UK were published in 1998 (Biddle, Sallis, & Cavill, 1998). The current UK government guidelines recommend that children aged 5 to 18 undertake at least 60 minutes per day of moderate to vigorous physical activity (MVPA) and minimise time spent in sedentary activities (Department of Health, 2011).

The research to date looking at childhood physical activity suggests that not all children are sufficiently active, with only 56% of 12 to 13 year old girls and 71% of boys meeting the physical activity guidelines. More recent research suggests that up to 50% of children do not meet the guidelines (Limb, 2013; Warburton, Nicol, & Bredin, 2006). Studies show that older children and girls are generally more inactive (Griffiths, Cortina-Borja, Sera, Pouliou, Geraci, Rich, ... & Jebb, 2013; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Thompson, Baxter-Jones, Mirwald, & Bailey, 2003). Physical activity in childhood and adolescence tracks into adulthood; children have been found to become less physically active and more sedentary with age, and also during the transition from primary school to secondary school (Marks, Barnett, Strugnell, & Allender, 2015; Morton, Atkin, Corder, Suhrcke, & Sluijs, 2016).

Less data are available for childhood sedentary behaviours than physical activity. Children in the UK spend between 7 and 8 hours per day being sedentary (Joint Health Surveys Unit, 2008). Girls have been found to spend more time in sedentary activities than boys (Gomes, dos Santos, Santos, Pereira, Chaves, Katzmarzyk, & Maia, 2014). Other factors, which have been shown to be associated with increased time spent in sedentary activities, are: those from less deprived areas, with parents with higher educational attainment, with higher family income and those without a garden (Gomes, *et al.*, 2014; Pulsford, Griew, Page, Cooper, & Hillsdon, 2013).

Many studies use television viewing as a proxy for sedentary time, however this has been found to be a poor indicator of total sedentary time (Biddle, Gorely, Marshall, Murdey, & Cameron, 2003). In youth low socioeconomic position (SEP) is associated with higher television viewing time but lower overall sedentary time (Coombs, Shelton, Rowlands, & Stamatakis, 2013). Very few studies have looked at school level factors and their relationship with sedentary

time; individual and family characteristics appear to be more important than school factors (Gomes, *et al.*, 2014).

School factors that have been shown to be related to decreased physical activity/increased sedentary behaviours include: mode of transport to school (active vs inactive), encouragement to participate in sport, moving schools between primary and secondary school (those who change school become less active) and emphasis on academic achievement above participation in physical activity (Marks, *et al.*, 2015; Morton, *et al.*, 2016). However most of these studies look at change in physical activity as opposed to sedentary behaviour and it is known that physical activity and sedentary behaviour are not directly inversely linked (Borraccino, Lemma, Iannotti, Zambon, Dalmasso, Lazzeri, ... & Cavallo, 2009).

A variety of factors have been shown to affect physical activity levels and sedentary behaviour, including both residential and school factors (Inchley, Currie, Todd, Akhtar, & Currie, 2005), Region (Wilkin, Mallam, Metcalf, Jeffery, & Voss, 2006), school level (Brodersen, Steptoe, Boniface, & Wardle, 2007), socio-economic status (Wilkin, *et al.*, 2006; Brodersen, Steptoe, Williamson, & Wardle, 2005; Gordon-Larsen, Nelson, Page, & Popkin, 2006), and surrounding area have also all be found to contribute to childhood physical activity levels (Kristjandottir, & Vilhjalmsson, 2001; Wheeler, Cooper, Page, & Jago, 2010) Compulsory physical education lessons in schools and voluntary extra-curricular activities contribute to the increase in a child's physical activity during week days (Connelly, Duaso, & Butler, 2007; Griew, Page, Thomas, Hillsdon, & Cooper, 2010; Trayers, Cooper, Riddoch, Ness, Fox, Deem, & Lawlor, 2006), yet this may be dependent on the number of extra-curricular sports clubs available and the school facilities (Durant, Harris, Doyle, Person, Saelens, Kerr,... & Sallis, 2009; Fairclough, & Stratton, 2005; Senne, Rowe, Boswell, Decker, & Douglas, 2009). There is little research regarding the relationship between childhood physical activity levels and school type (independent or state run school) (Aarnio, Kujala, & Kaprio, 1997). This study sought to examine the association between individual physical activity and sedentary behaviour of children, by sex, school type, residential deprivation, and whether children were meeting physical activity guidelines.

2. METHODS AND MATERIALS

2.1 Participants

Individual level data were collected from children in Year 8 (aged 12 to 13 years) attending three secondary schools (one co-ed state school and two single-sex

selective independent schools) in Sheffield, a large city in the north of England with higher than average deprivation (Department for Communities and Local Government, 2011). State and independent schools were matched according to the index of multiple deprivation of their location. To further enhance matching, independent schools with small numbers (less than 49 year 8 pupils) and faith schools were excluded.

2.2 Data Source

The individual level data were collected using the Youth Physical Activity Questionnaire (YPAQ) (Corder, van Sluijs, Wright, Whincup, Wareham, & Ekelund, 2009), which lists 47 activities, and has been found to be a suitable tool for ranking this age group accurately with regards to MVPA (Corder, *et al.*, 2009). In the YPAQ, children self-report on the frequency and duration of each activity undertaken in the previous week. Each activity was assigned a MET value, obtained from the youth compendium of energy expenditures, or, if not listed, from the adult compendia (Ridley, Ainsworth & Olds, 2008; Ainsworth, Haskell, Whitt, Irwin, Swartz, Strath, ... & Jacobs, 2000; Ainsworth, Haskell, Herrmann, Meckes, Bassett Jr, Tudor-Locke, ... & Leon, 2011). Activities with a MET value of 3.00-5.99 were classed as moderate, and those with a value of 6.00 or more as vigorous, activity (Nader, *et al.*, 2008; Ridley, *et al.*, 2008; Mota, Santos, Guerra, Ribeiro, & Duarte, 2003). The MET-minutes for each individual activity for each child over the week were calculated (minutes of activity x frequency x MET value = MET minutes) then summed. Age, sex and residential deprivation score (calculated from residential postcode and Index of Multiple Deprivation score) (Department for Communities and Local Government, 2011) were also collected.

A difference in means sample size calculation using standard assumptions of 80% power and $\alpha=0.05$, to detect a difference of 100 minutes MVPA per week, required a sample size of 61 children per group.

2.3 Data Analysis

The children's characteristics were described. The mean individual moderate and vigorous physical activity (MVPA) MET-minutes per week were calculated, stratified by school type (state/independent), sex (boy/girl) and residential deprivation category (low<13; medium; high>26). These data were used to determine the percentage meeting the physical activity guidelines (i.e. minimum MET-minutes per week of 1260), in total and by school type, sex and residential deprivation category. These MVPA data were broken down into the constituent

parts: timetabled school physical activity, active travel to school, with ‘activity’ as the balance (e.g. basketball, running). Separately, sedentary behaviour (e.g. homework, media time) (MET minutes per week) was calculated. Note, sedentary + MVPA = total MET minutes per week. Children who reported no minutes of sedentary behaviour in a week were excluded from the analyses of sedentary data.

Differences between groups were evaluated using unpaired *t*-test (homoscedasticity was assessed using Levene’s test), chi squared or Kruskal-Wallis test as appropriate to data. A linear regression model, with individual child MVPA MET-minutes per week as outcome and sex (boy/girl), school type (state/independent), and deprivation score (low/affluent; medium; high) as predictor variables. This was repeated for sedentary MET-minutes. A logistic regression model was used to examine whether children met the physical activity guidelines as outcome, again with sex, school type and deprivation as independent variables. All data were analysed using IBM SPSS Statistics (version 22).

Consent was obtained from parents and children (Opt-In for the independent schools; subsequently swapped to Opt-Out consent for state schools). Ethical approval was obtained from the University of Nottingham Faculty of Medicine and Health Research Ethics Committee.

3. RESULTS

Three schools were invited to participate in the study and accepted. Across these schools, 346 children were invited to take part, with a 60% response rate (n=208). 19 incomplete questionnaires were returned, which were excluded, resulting in 189 school children (67% state school children). Mean age was 13.4 years (range 12.8-14.0 years).

Table 1: Summary of children’s characteristics (n=189 by school/sex; n=147 by IMD due to 42 missing postcode data)

Number (%)	Boys	Girls	Total
Low IMD	18 (44%)	23 (56%)	41 (28%)
Medium IMD	28 (52%)	26 (48%)	54 (37%)
High IMD	19 (37%)	33 (63%)	52 (35%)
State School	62 (49%)	65 (51%)	127 (67%)
Independent School	20 (32%)	42 (68%)	62 (33%)
Total	82 (43%)	107 (57%)	189

Table 1 summarises the children’s characteristics. 107 (57%) girls and 82 (43%) boys participated, with more boys from state schools, 62 (76%); compared with 20 (24%) from independent schools, in part due to the low response rate (Opt-In

consent) from the boys-only independent school ($p=0.031$). Roughly equal proportions of children resided in each deprivation group (28% - 37%). However by sex, the data show that the biggest difference between girls and boys is for areas of high Index of Multiple Deprivation (deprived areas) where there are more girls (63% vs 37% respectively). (Note, $n=147$ for deprivation data due to missing or erroneous postcode data).

Children at independent schools resided in more affluent areas on average; mean deprivation scores were 32.4 and 12.6 for state and independent school children respectively ($p<0.001$) (noting that a higher score is a more deprived area). The data range show that both state and independent schools have children residing in affluent areas, but only state school children reside in more deprived areas (state school children range 7 to 63; independent school children range 2 to 37).

The physical activity levels and sedentary behaviour of the children are summarised in Table 2, stratified by sex, school type and residential deprivation score.

Table 2: Summary of children's physical activity levels, by sex, school type, and residential deprivation score

	State school	Independent school	p value	Low IMD	Medium IMD	High IMD	p value	Total	p value (95% CI)
Mean total MET minutes per week	4202	6992	<0.001	6976	5472	4320	<0.001	5117	
- Girls	4145	6761	<0.001	7301	5570	4496	0.009	5172	0.792 (-1061, 810)
- Boys	4262	7478	<0.001	6562	5380	4013	0.023	5046	
Mean MVPA MET mins pw	2601	3786	0.003	3605	3291	2790	0.405	2990	
- Girls	2617	3331	0.105	3289	3186	2866	0.984	2897	0.513 (-428, 855)
- Boys	2585	4741	<0.001	4008	3388	2656	0.170	3111	
Mean activity MET minutes per week	2297	3519	0.002	3372	2913	2517	0.310	2698	
- Girls	2302	3046	0.079	3001	2718	2620	0.916	2594	0.446 (-379, 858)
- Boys	2291	4514	<0.001	3846	3094	2339	0.089	2833	
Mean timetabled physical activity at school (MET minutes per week)	137	147	0.778	142	180	127	0.855	141	
- girls	169	174	0.917	168	273	136	0.262	171	0.038 (-138, -4)
- boys	103	91	0.675	109	94	110	0.955	100	
Mean active travel to school (e.g. walking) (MET minutes per week)	168	119	0.255	91	197	146	0.182	152	
- girls	146	111	0.481	120	195	110	0.289	132	0.271 (-35, 124)
- boys	190	135	0.491	53	199	207	0.692	177	
Sedentary mean MET mins per week	1882	3206	<0.001	3456	2617	1693	<0.001*	2365	0.600 (-791, 458)
- girls	1712	3430	<0.001	4012	2817	1735	<0.001	2434	
- boys	2080	2737	0.194	2704	2426	1611	0.074	2268	
Number (%) children meet guidelines	90 (71%)	54 (87%)	0.014	36 (88%)	42 (78%)	37 (71%)	0.154	144 (76%)	
girls	46 (71%)	35 (83%)	0.139	20 (87%)	20 (77%)	25 (76%)	0.559	81 (76%)	0.857
boys	44 (71%)	19 (95%)	0.027	16 (89%)	22 (79%)	12 (63%)	0.172	63 (77%)	

N for activity data: 82 boys, 107 girls, 127 state; 62 independent; 41 affluent, 54 medium IMD, 52 high deprivation

N for sedentary data: 70 boys, 100 girls, 108 state; 62 independent; 40 affluent, 45 medium IMD, 47 high deprivation

*Pairwise comparisons Groups 1-2 $p=0.020$ (total), $p=0.293$ (girls); Groups 1-3 $p<0.001$ (total), $p<0.001$ (girls); Groups 2-3 $p=0.012$ (total), $p=0.052$ (girls)

MVPA:

Boys did slightly more MVPA than girls (mean MVPA boys 3111 METmins pw; 2897 girls; $p=0.513$). There was little difference in amount of 'active travel' by sex. Girls did more timetabled physical activity than boys ($p=0.038$; 95% confidence interval 4 to 138 METmins pw). (See Table 2). Whilst there was little difference between boys and girls in the total amount of MET minutes per week in 'activities' ($p=0.446$), when these data are broken down by type, there are some activities that girls participated in more than boys (e.g. aerobics, dancing, gymnastics) and some more boys than girls (e.g. baseball, cricket, football) ($p<0.05$, see Table 3). There were no statistically significant differences between the sexes for the other activities (e.g. hockey, martial arts, running).

Children at the independent schools did more MVPA per week than those at state schools (mean MVPA independent 3786; state 2601; $p=0.003$; 95% confidence interval 412 to 1957 METmins per week). This was due to differences in 'activities' rather than timetabled physical activity or active travel ($p=0.002$; 470 to 1976 METmins per week). See Table 2. The activity data are broken down by type in Table 3. This shows that there were statistically significant differences in activity type between children at state and independent schools for cricket, racquet sports, and horse riding (independent higher; $p=0.048$, 0.007, and 0.018 respectively).

If the data are cross-classified by school type and sex, we see that both boys and girls at independent schools are more active than children at state schools - this is particularly strong for boys ($p<0.001$; 1129 to 3184 METmins pw) and non-significant for girls ($p=0.105$). Boys at independent schools are the most active (mean MVPA 4741 METmins pw). Girls at independent schools are more active (mean MVPA 3331) than girls and boys at state schools. Interestingly, boys at state school are less active than state school girls (MVPA 2585 and 2617 respectively) ($p=0.917$; 95% CI -645, 580). If the data are examined within school, independent school children trend towards boys being more active ($p=0.064$; 95% CI -85, 2905), whilst boys and girls at state schools are equally active ($p=0.917$; 95% CI -645, 580). (See Table 2).

Children in the affluent group had the highest mean MVPA (3605 METmins pw) although the effect was not statistically significant ($p=0.405$); this held by sex. The data show little difference in activity type by residential deprivation category. The only activities with statistically significant differences between groups were playing on playground equipment (more frequent in children living in affluent areas than the other two areas ($p=0.024$ and 0.007)) and rollerblading/roller-skating (more frequent in the most deprived areas than the other two ($p=0.011$ and 0.011)).

Table 3: Summary of regression model results examining the association between MVPA and sedentary behaviour with sex, school type and residential deprivation

Model	<i>r</i>	<i>R</i> ²	β	95% CI	<i>P</i>
MVPA MET mins pw:	0.262	0.069	-	-	0.017
- School type	-	-	1318	348, 2289	0.008
- Sex	-	-	-457	-1230, 316	0.244
- Residential deprivation	-	-	83	-509, 676	0.781
Sedentary MET mins pw:	0.388	0.150	-	-	<0.001
- School type	-	-	727	-156, 1610	0.106
- Sex	-	-	444	-263, 1151	0.217
- Deprivation score	-	-	-635	-1171, -98	0.021
Logistic model:					
Meet MVPA guidelines:	0.276	0.076	-	-	
- School type			-1.217	0.097, 0.905	0.033
- Sex			0.011	0.443, 2.310	0.979
- Deprivation score			-0.001	0.972, 1.026	0.931

Linear regression modelling (see Table 3) showed that school type was positively associated with MVPA ($\beta=1318$ MET minutes per week; 95% confidence interval 348 to 2289, $p=0.008$), although the model explained just 7% of the variation in physical activity levels. That is, children at these independent schools were more active than those at the state schools. The data for sex showed a negative relationship (boys more active) that was not statistically significant ($p=0.244$). Deprivation score had a weak effect on physical activity levels ($\beta=83$; $p=0.781$).

Sedentary Behaviour:

Boys and girls had similar levels of sedentary behaviour (1936 boys; 2274 girls; $p=0.261$). Nonetheless there were differences in how they spent their sedentary time. Girls did significantly more art/craft, listening to music, talking and travelling, whilst boys spent more time on computer games.

Children at independent schools also reported more sedentary behaviours ($p<0.001$; 717, 1930 METmins per week), although this effect was not significant for boys (Table 2). Children at independent schools spent significantly more time doing homework, playing instruments, reading, sitting talking, travelling and watching tv/videos. State school children reported spending more time playing computer games.

Children residing in affluent areas also reported more sedentary behaviours ($p<0.001$), which held for girls. Pairwise comparisons show that low and high deprivation groups were statistically significantly different ($p=0.001$) but not between the other two pairs; similarly for girls (Table 2). When sedentary

behaviour is broken down, the data show that the children living in affluent areas reported doing the most homework and reading and those in highly deprived areas the least. Children in affluent areas reported more playing indoors and watching tv/videos and those in highly deprived areas reported less time spent travelling.

The regression model (Table 3) showed that residential deprivation score was statistically significantly negatively associated with sedentary behaviour (higher deprivation, less sedentary behaviour i.e. affluent areas more sedentary) ($\beta = -635$ MET minutes per week; 95% confidence interval -1171 to -98, $p = 0.021$), with the model explaining 15% of the variation in sedentary behaviour. School type and sex were positively associated (independent school children and girls more sedentary); these were not statistically significant ($p = 0.106$ and 0.217 respectively). This suggests the earlier univariate relationship between school type and sedentary behaviour is confounded by residential deprivation.

Meeting Guidelines:

Children at independent schools were more likely to meet the physical activity guidelines (87% independent; 71% state; $p = 0.014$; odds ratio 2.8x) (Table 2). This was only statistically significant for boys (boys 95% independent, 71% state, $p = 0.027$, odds ratio 7.8x; girls 83% independent, 71% state, $p = 0.139$, odds ratio 2.1x). Children, whether boys or girls, in the most deprived areas were the least likely to meet the physical activity guidelines and those in affluent areas the most likely ($p = 0.154$). The odds ratio shows affluent children are 2.5x more likely to meet the physical activity guidelines than children residing in medium or high deprived areas (boys 3.1x; girls 2.1x). There was no difference between sexes in proportion meeting physical activity guidelines (76-77%; $p = 0.857$).

The logistic regression model showed only school type had a significant association with meeting physical activity guidelines ($p = 0.033$), with children at independent schools being more likely to meet the physical activity guidelines (Table 3). The model explained 8% of the variation in the data.

4. DISCUSSION

This study shows that children at independent schools had higher weekly MVPA levels than the children at the state schools, with particular activities favoured by sex or school type. Sedentary behaviour was lowest in children living in the most deprived areas, which held in the multivariate model. Boys were more active than girls, but this was not statistically significant. Boys at independent schools were 7.8x more likely to meet the physical activity guidelines than boys at state schools

(2.8x across all children). Similarly boys living in affluent areas were 3.1x more likely to meet the guidelines (2.5x across all children).

In the UK, 6.5% of children attend independent schools, which parents opt for due to numerous reasons (McCormack, 2011). School type was found to be a significant predictor of MVPA MET minutes per week (increased activity at independent schools). On average pupils attending independent schools achieved 1185 MVPA MET-minutes more of physical activity per week than those at state schools. This association has been demonstrated in other developed countries (Brodersen, *et al.*, 2005; Griew, *et al.*, 2010; Feldman, Barnett, Shrier, Rossignol, & Abenhaim, 2003; Olds, Tomkinson & Baker, 2003) and was stronger for boys (Griew, *et al.*, 2010; Babey, Diamant, Brown, & Hastert, 2005; Bauman, Reis, Sallis, Wells, Loos, Martin, & Lancet Physical Activity Series Working Group, 2012). However, there was no significant difference in the number of MET minutes per week attributable from timetabled physical activity or active travel to school. More of the difference in physical activity levels came from independent school children's higher leisure time physical activity, particularly in certain activities such as cricket. Given that there is also a correlation between independent schools and deprivation (i.e. independent school children only live in more affluent areas, whereas many state school children reside in highly deprived areas), this suggests that more independent school children come from wealthier families who can, perhaps, afford to enroll their children into more sport and activity clubs.

The habitual physical activity findings in this study are corroborated by the Health Survey for England 2007, which showed similar percentages of 12 to 13 year old children meeting physical activity guidelines, with girls being less active than boys (Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; Trost, Pate, Sallis, Freedson, Taylor, Dowda, & Sirard, 2002). Deprivation score was negatively associated with habitual physical activity levels (Wilkin, *et al.*, 2006; Brodersen, *et al.*, 2005; Gordon-Larsen, *et al.*, 2005; Joens-Matre, Welk, Calabro, Russell, Nicklay, & Hensley, 2008; Macintyre, & Mutrie, 2004).

The activities that boys and girls spend time in differ. Girls reported significantly more time spent in aerobics, dancing, gymnastics, swimming for fun, horse riding, rollerblading and walking/hiking; whereas boys reported spending significantly more time doing basketball, cricket and football. There was no significant difference for the other activities, including but not limited to: hockey, martial arts, running, swimming lessons, racquet sports and bike riding.

Measurement techniques for sedentary behaviour are less well defined than those for physical activity. Children in affluent areas recorded more total sedentary minutes per week than those in more deprived areas; this was found to be largely due to higher homework and reading commitments. While this may

seem unlikely it is thought that physical activity and sedentary behaviours are not inversely related and it has previously been found that children and adolescents who report more physical activity can also report more sedentary activity, as these activities occur at different times and have unique determining factors (Borraccino, *et al.*, 2009).

In terms of meeting physical activity guidelines, whilst many children did meet physical activity guidelines, this was not true for all children. Further, there are clear differences by school type, particularly for boys. This suggests that more needs to be done to enable state school children to be more active, both in school and outside of it. An example of an initiative during school time being the Lunchtime Enjoyment Activity and Play (LEAP) Australian intervention in schools which integrates reusable, everyday materials into child-friendly exercises to promote not only physical activity but also intra- and interpersonal skills (Hyndman, Benson, & Telford, 2014). In addition Jago and Baranowski's systematic review found that many non-curricular interventions can have a positive impact on children's physical activity, for example through active travel to school and activities during break times (Jago, & Baranowski, 2004). The strong influence of childhood physical activity levels for attitudes towards physical activity in later life (Kjonniksen, Fjortoft, & Wold, 2009; Cleland, Dwyer & Venn, 2012; Jose, Blizzard, Dwyer, McKercher, & Venn, 2011) imply that these differences between children could have long-term health, social and economic implications.

This study has a number of strengths. Analyses were based on a good sized dataset with good response rates, adding to previous similar studies (Keresztes, Piko, Pluhar, & Page, 2008; Kirby, Levin, & Incheley, 2012). All schools recruited were in Sheffield, in the North of England, in areas of low deprivation, decreasing the risk of confounding due to school level deprivation. Additionally all children involved attended schools with single sex physical education lessons preventing any school level effect associated with some children participating in coeducational physical education lessons. The data were collected using the YPAQ which is a validated physical activity questionnaire for this age group. It has been shown that data from questionnaires accurately ranks individuals in terms of physical activity (Corder, *et al.*, 2009), which was the purpose of this study. If a child's activity was not listed in the youth compendium, the listed value for an adult was used which may have led to an over-estimation of some children's energy expenditure. Causal inference cannot be made as the data in this study were of cross-sectional nature. Nevertheless this study allows for a focused insight of children's ability to meet the government's physical activity recommendations and, in particular, how this varies by school type.

5. CONCLUSIONS

This study is the first, to the authors' knowledge, to compare physical activity and sedentary behaviour of school children across independent and state schools, residential deprivation score and sex. This study found that children at independent schools, particularly boys, were significantly more active than their state school counterparts and were more likely to meet the government guidelines for physical activity. Differences were also found in relation to residential deprivation for sedentary behaviour.

Low levels of physical activity in childhood could lead to long-term health problems for the nation given the childhood influence on later life attitudes towards physical activity and the corresponding health issues associated with physical inactivity. These findings should add to the evidence to investigate schools' physical activity provision for children, and investigate ways, whether voluntary or legislative, to increase provision with school type and deprivation level taken into account. Tailor-made programmes to increase physical activity in children both in and out of school may be necessary to achieve this goal.

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