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Effect of a school-based active play intervention on sedentary time and physical activity in preschool children

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Abstract

Early childhood is a critical time for promoting physical activity. Few studies have investigated the effect of interventions in this population. The aim of this study was to investigate the effect of a school-based active play intervention on preschool children's sedentary time and physical activity. Preschool children were recruited from randomly selected preschools. Schools were randomly assigned to an intervention or comparison group. One teacher per intervention school received training from active play professionals in the delivery of a 6-week active play programme. Comparison schools continued their usual practice. Children wore a uni-axial accelerometer for 7 days at baseline, immediately after and at 6-month post-intervention. No significant intervention effects were observed for sedentary time or physical activity. However, sex and hours spent at school were significant predictors of physical activity. Children who spent fewer hours (half-day children) at school were significantly more active than their full day counterparts. Physical activity during the intervention classes was high even though neither daily physical activity nor sedentary time changed. Notably children who spent more time at preschool were less active suggesting that preschool was not as conducive to physical activity engagement as other environments.

Introduction

The preschool years have been identified as an important time for the development of healthy behaviours, such as physical activity (PA) [1]. Moreover, play and the mastery of fundamental movement skills are the substrate of PA during this formative stage [2], which provides the foundation for lifelong engagement in PA [3–5]. During early childhood, PA significantly contributes to the prevention of obesity [6, 7] and cardiovascular disease [8, 9], it influences bone health, motor development [10, 11] and promotes positive cognitive functioning and social development [12]. PA guidelines in the United Kingdom recommend that children below the age of 5 years who are capable of walking should participate in at least 180 min of PA (light intensity and above) and reduce the amount of time spent being sedentary [13]. Despite preschool children being the most active segment of the population, a large proportion of young children are insufficiently active and spend a substantial amount of time being sedentary [14–16]. The childcare environment provides one setting where interventions may be delivered to increase PA [17]. However, few interventions have targeted preschool settings [18, 19]. The preschool infrastructure [20] and willingness of staff to participate in PA programmes [21] have prompted researchers to explore the potential of this environment for increasing PA. Despite this, not all staff working with preschool children feel confident enough to deliver PA within their setting [22]. Consequently, the need for curriculum-based interventions implementing developmentally appropriate PA involving staff development is needed [23, 24]. Despite the importance of play on preschool children's physical, cognitive, emotional and social development [25], promoting active play has been under researched [26]. During the early years of life, children engage in active play that is significantly above resting metabolic rate [27]. This play is often unstructured and usually occurs outdoors [28]. Previous research with older children (9–11 years) has found that active play is positively associated with moderate-to-vigorous PA (MVPA) levels [26]. Activity during play can be increased, for example, by painting markings on playgrounds to promote active games, with significant increases observed in the shorter [29, 30] and longer-term [31]. Further, play equipment and activity cards with games ideas, instructions and adaptations [32] and the use of portable equipment at day care facilities [33] have also increased children's PA. Despite the encouraging findings from active play interventions in school-age children, there is a paucity of evidence concerning interventions that promote active play in preschool children. Therefore, the aim of this study was to investigate the effect of a curricular active play intervention on children's sedentary time (ST) and PA levels.

Materials and Methods

Participants and Settings

Twelve preschools were randomly selected and invited to take part in the study. Schools were attached to a SureStart children's centre, which provides advice and support for parents of children <5 years old, who reside in the most disadvantaged areas of England [34]. Schools were located in neighbourhoods in the highest 10% for national deprivation [35]. All schools agreed to participate.

Initially, all parents were invited to a meeting at their respective school where the details of the project were outlined. Parents who were unable to attend the meeting were given an information pack outlining the project details. All children aged 3–4.9 years were invited to participate in the project (n=673) and asked to return informed written parental consent and medical forms. Two hundred and forty children (mean age 4.5 years, SD=0.6 years; 51.7% male) agreed to participate. The children and their families were made aware that they were free to withdraw from the study at any point, without providing a reason. Subsequently, schools were randomly allocated to either the intervention (n=6) or the comparison group (n=6). Randomization was accomplished by drawing folded sheets of paper, each marked with a school's code, from a hat. Allocation alternated between groups, that is first, third, fifth school into intervention group. Although web or computer-based randomization techniques exist, this randomization procedure remains acceptable for samples of n≤60 [36]. Participants and researchers were not blinded to the experimental group. The flow of participants through the study is illustrated in Fig. 1 [37]. The study was approved by the University Ethics Committee.

Intervention group

This cluster randomized controlled trial was conducted across two academic years (from October 2009 to November 2010). Of the 12 schools recruited, six were allocated into Phase 1 (Academic Year 1) and six were allocated into Phase 2 (Academic Year 2), meaning that three schools were added to each group during each phase. This design aimed to maximize recruitment and control for the influence of seasonal variation [38]. Each active play intervention was conducted for 6 weeks to fit with the school calendar and stay within budget. Assessments were conducted at baseline, immediately following the 6-week intervention and again at 6-month follow-up. The project time line is outlined in Supplementary data. PA provision in preschools in the United Kingdom is usually designed and led by classroom teachers or assistants. Few preschools have specialist physical education teachers [39]. For this reason, the use of external play practitioners for a period of time during a school term is becoming increasingly popular with approximately 50% of SureStart centres in the United Kingdom using external agencies [39].

The active play intervention aimed to increase PA and decrease ST by training staff in delivering an active curriculum. The intervention was designed using elements of the socio-ecological model [40] and aimed to influence children's PA and time spent sedentary. This was achieved by manipulating known mediators and moderators in the child's social environment [41]. Specifically, the intervention targeted the child's teacher and school environment as key agents for PA promotion. The premise of the active play intervention was based around providing staff development and on-going support for teachers who are not typically physical education specialists, which is common in the UK preschool setting. Schools in the intervention group received the full active play programme, which was designed and implemented by experienced and appropriately qualified active play professionals from the sport and leisure directorate of the local authority. The active play programme was a 6-week educational programme for staff and children in preschool settings that was delivered using a 2–2–2 delivery approach. Specifically, exemplary instruction occurred for the first 2 weeks, followed by co-instruction of preschool staff in conjunction with active play staff for an additional 2 weeks. Independent instruction by preschool staff members was supported by the active play professionals for the final 2 weeks. These sessions occurred once per week and lasted for approximately 60min. When the active play professionals left the setting, continuation of programme delivery by preschool staff was promoted. Additionally, intervention schools received additional support, where necessary, whilst the programme was on going. Examples of support included ideas for extra games or assistance with active fun days.

A comprehensive resource pack, grounded in the principles of the UK preschool curriculum (Early Years Foundation Stage), was provided to each school. The pack included 20 activity cards (a full description of example cards can be found in the Supplementary data), a user manual focusing on topics such as 'Getting activity at the right level', 'Maximizing moderate and vigorous activity levels' and 'Including all children', exemplar lesson plans, signposting information, and a poster promoting active play.

Comparison group

Comparison schools were asked to continue to deliver their usual PA provision. Given the length of the proposed follow-up (6 months) and schools interest in the initiative, the resource pack was offered to schools at the start of the project to provide information to schools but no guidance was given about how to use the resource pack.

Instruments and Procedure

Physical activity: PA and ST were measured using an accelerometer set to record at 5-s epochs over seven consecutive days (GT1M ActiGraph Pensacola, FL.). Children were asked to wear the accelerometers on an elastic belt on their right hip (anterior to the iliac crest) during all waking hours except for water-based activities. Accelerometry has been validated against direct observation in preschool-aged children and is an acceptable measure of PA for this population [42, 43].

MVPA was also measured during Week 3 of the active play programme when the same session content was taking place in each school. This session was chosen as it marked the mid-point of the intervention. Researchers visited three intervention and three comparison schools during an active play session. For convenience, 60 children (30 intervention and 30 comparison) were randomly selected from six schools and asked to wear an ActiGraph uniaxial accelerometer for the duration of the session. Data were reduced using the same protocol as described for daily PA.

Data Management

MAHUffe software (Analyser v 1.9.0.3) was used to analyse the collected data. Age-specific cut-points were used to determine time spent sedentary or participating in light, moderate or vigorous PA [43]. The cut-points which are validated against 15-s epochs were divided by 3 to reflect that activity data which had been collected using 5-s epochs. Periods of 20 min of consecutive zeros were removed from the data as these were considered periods of non-wear time [44]. To be included as a valid measurement day, the accelerometer was required to be worn for a 623 min at baseline, 565 min at post-test and 563 min at follow-up per day. These wear times were calculated by defining 80% of the total length of time during which 70% of the sample wore the accelerometer [45]. Children were included if they wore the monitor for a minimum of 3 days including one weekend day [28, 46].

Anthropometrics

Body mass was measured (to the nearest 0.01 kg) using digital scales (Tanita WB100-MA, Tanita Europe, The Netherlands). Stature was measured (to the nearest 0.1 cm) using a portable stadiometer (Leicester Height Measure, SECA, Birmingham, UK). BMI [mass (kg)/stature2 (m)] was calculated and children were classified as underweight, normal weight, overweight or obese using sex- and age-specific cut-points [47].

Parental Characteristics Questionnaire

Parental and community characteristics were assessed using the Parental Characteristics Questionnaire. This questionnaire was devised using a combination of ALSPAC questionnaires [48–50], which included question categories such as ‘Having a Baby’, ‘Your Environment’, ‘About Yourself’ and ‘Adult Learning’. The questionnaire comprised eight items. Items 1–3 focused on general information about the child and parent including sex, birth dates, adult’s relationship to the child and how many hours the child attended school each day (3 hours=half day and 6 hours=full day). Items 4–6 focussed on the parents’ backgrounds including home postcode, ethnicity and current marital status. Items 7–8 focussed on the parent’s level of education and current employment status. All answers required a ‘tick the box’ response with the exception of postcode where the full postcode was supplied and used to obtain an index of multiple deprivation. For each participant, socioeconomic status (SES) (total deprivation rank) was derived from home postcodes entered into the Office for National Statistics online application [35]. Two hundred and thirty-eight children’s homes (99.2%) were located in the highest 10% for deprivation nationally. The remaining two children’s homes were in neighbourhoods in the top 30% for national deprivation.

Data analysis

Full PA data were obtained for 86 boys (35 intervention, 51 comparison) and 70 girls (35 intervention, 35 comparison) at all three time points and used in subsequent analyses. Reasons for missing data included non-compliance when wearing the accelerometer (n=65), technical problems (n=12), sickness (n=3), loss of accelerometers (n=3) and moving school (n=1). Descriptive statistics were calculated to describe the final sample of 156 (Table I). Independent t-tests were conducted to examine any differences in sex, SES, ethnicity, weight status, group allocation and enrolment at school, between children who were excluded and included in the PA analyses. In addition, independent- samples t-tests were performed to determine whether there were any significant differences in the percentage of time spent participating in MVPA between the intervention and the comparison groups during the active play sessions. These data were analysed using PASW Statistics v.18 with significance level of $P \leq 0.05$.

The main analysis used to estimate the effect of the intervention on children’s PA levels and ST was multilevel modelling, which is considered the most appropriate data analysis technique for nested data [51]. Data were analysed using MLwiN v.2.23 software (Centre for

Multilevel Modelling, University of Bristol, UK). A three-level multilevel data structure was used to determine the effects of the active play intervention. The three levels of analysis were time point (baseline, 6 weeks, 6 months; Level 1), child (Level 2) and school (Level 3). An association model was used to determine the effects of the intervention after being corrected for confounding variables, therefore estimating any relationship or association as accurately as possible [52]. Time spent in ST, light PA (LPA) and MVPA were defined as the outcome variables. Baseline values for ST, LPA, MVPA, BMI and accelerometer wear time (continuous variables) and time-point, sex, time spent at school, parents levels of education and ethnicity (categorical variables) were used as covariates. Dummy variables were created for time point enabling analyses of a 6-week and 6-month intervention effect. Two analyses were conducted on all three outcome variables (ST, LPA and MVPA) to examine the intervention effect over time points. The first analysis (crude analysis) determined the effect of the intervention over time whilst controlling for baseline PA, whilst the second analysis (adjusted analysis) determined the intervention effect when the covariates were added to the model [52]. Regression coefficients in the model were assessed for significance using the Wald statistic [52]. Statistical significance was set at $P<0.05$.

Results

Exploratory analysis

Independent-samples t-tests revealed no statistically significant differences in PA variables (ST, LPA, and MVPA) between boys and girls, between those who remained in the study and those who dropped out or between children with complete and incomplete PA data ($P>0.05$). The descriptive (mean, SD) anthropometric characteristics and ethnic background of the children are displayed in Table I. Independent-samples t-tests revealed no significant differences between boys and girls in the intervention and comparison groups for age and anthropometric data ($P>0.05$). Eighty-four percent and 75%of the intervention and comparison group were white British, respectively. Table II summarizes the raw, unadjusted scores for the children’s PA levels. Time spent in different intensities of PA during active play sessions is reported in Table III. Children in intervention sessions were significantly more active than those in comparison sessions ($P<0.001$). There were no differences by sex within sessions ($P>0.05$).

Main analyses - testing the intervention effect

Table IV shows the effect of the intervention on ST, LPA and MVPA at 6-week and 6-month post-intervention on the children included in the analysis (n=156). No intervention effect was found for ST, LPA or MVPA at 6 weeks or 6 months in the crude or adjusted model. However, the amount of hours children spend at school was significant predictors of ST, LPA and MVPA in the adjusted models. The results indicated that girls engaged in 11.3 min more ST (CI: 4.6 to 17.9) and 3.2 min less LPA (CI:-5.2 to 1.2) than boys. Additionally, children who attended school for 6 hours (whole school day) engaged in 11.4 min more ST (CI: 3.8 to 19.0) and 6.2 min less (CI: -9.3 to -3.1) MVPA than children who attended school for 3 hours (half day). Analysis also revealed that accelerometer wear time was a significant predictor of ST with children who wore the accelerometer for longer accumulating more ST.

Discussion

The aim of this study was to investigate the effects of an active play intervention on children's whole week ST and PA levels. This study found that the inclusion of six structured active play sessions, co-delivered by experienced active play professionals and school teachers, was not effective in decreasing children's ST or increasing PA over time. Moreover, children did not meet PA recommendations. Preschoolers in this study were sedentary for 10.8 hours of their total waking day similar to other studies [53–55]. Although the high levels of ST that children engaged in were worrying, these data provided a strong rationale for interventions that aim to decrease ST time.

Contrary to our findings, previous research has demonstrated that increasing the provision of outdoor play equipment [56] or creating a more active curriculum [57] can significantly increase MVPA. However in both of these studies, the interventions were limited to one setting with small numbers of participants. When our 6-week intervention (one session per week) was implemented with a larger sample size and within more settings, the results were not as favourable as those reported in other studies [56, 57]. This is an important finding as it suggests that low burden curriculum driven interventions do not appear to be effective in changing daily PA and ST. Although this investigation examined the effects of simply adding an adult led active play session, during preschool time, other forms of preschool interventions have been investigated. Reilly et al. [4] used accelerometers to measure the effects of a 24-week enhanced PA programme in 36 nursery schools (three 30-min sessions a week for 24 weeks) that included home-based education aimed at increasing PA and reducing sedentary behaviour through play. Although the main outcome measure in the study of Reilly et al. was BMI, their intervention did not significantly increase children's activity levels. The investigators concluded that they did not deliver an adequate dose of PA, despite rigorous implementation of the intervention and promising results in a pilot study [58]. It may also be likely that three sessions per week may be difficult to incorporate into an already pressured curriculum. Another PA intervention implemented in 40 preschools in Belgium, found that using playground markings and equipment did not significantly increase PA levels of children [54]. In contrast to our findings, interventions have been conducted which have resulted in increases in PA [59, 60]. These studies were not 'play oriented', but were controlled in design with well structured, repetitive exercise regimes delivered frequently (5–6 times per week for 4–12 months). It is questionable whether these approaches were as developmentally appropriate as other studies that focus on physically play [25].

During the active play sessions, children in the intervention group were significantly more active than those in the comparison group, suggesting that the activities delivered were appropriately intense, but were not of sufficient duration or frequency to affect overall PA. It is estimated that during a 39-week school year, children in the active play specialist led sessions spent approximately 8 more hours in MVPA than children in the comparison sessions. Without the use of direct observation during the session, it was not possible to determine the precise activities that best promoted PA. It is recommended that future studies include an observational measure to contextualize the activity within the session [61]. Failure to increase PA out of school is generally consistent with previous studies [62] although some interventions among older children have been successful [63]. Programmes that increased children's PA relied mainly on external control such as parental reinforcement [9, 64] or PA at home [65]. Although limited by parent recall, using an activity diary in the future may capture this information. Another possibility for the lack of increase in MVPA may be attributed to the displacement of PA or the 'activitystat' hypothesis [66–68]. For example, on days when the children accumulated extra MVPA, they may have increased the amount of time spent being sedentary; whereas on a day where the children did not partake in MVPA, they might increase the amount of LPA they accumulated and decrease the amount of time in sedentary activities. Future studies should investigate total PA rather than specific intensities, particularly given the PA recommendations for this age group.

Despite observing no intervention effect, this study contributes to the limited intervention literature in this population. Levels of PA were very low and levels of ST were very high, which has been previously reported [15]. High levels of ST have been associated with excessive use of screen-based entertainment in this population [69]. However, we did not record information in relation to electronic media use and it was therefore difficult to state with confidence the reason for the high recordings of ST. It is also worth noting that accelerometer wear time decreased across time points. From discussions with parents and teachers, many children did not want to wear their activity monitor for the 7-day period. Future research should acknowledge this challenge and try to establish a solution which maximizes monitor wear time and improves compliance in such studies.

Boys were more active than girls, which is consistent with the literature [41, 70]. When potential pupil and school level confounding variables were investigated, girls spent significantly more time sedentary and less time in LPA. Over 6 months this accumulated to approximately 34 hours more ST for girls and 10 hours more LPA for boys. Girls also accumulated less MVPA than boys, though this was not significant. These sex differences have been consistently demonstrated in the literature with boys often being observed playing in larger groups, partaking in play which involves increased risk, and engaging in more ‘rough and tumble’ play often involving expansive body movements, thus expending more energy [71–73]. Another explanation for these sex differences may be that girls receive less encouragement from teachers and peers to engage in energetic play. A previous study examining PA behaviour among preschool children found no significant sex differences in prompts to be active [74]. Whatever the underlying reason for the observed sex difference, our observation that 3- to 5-year-old girls engaged in significantly more ST and less LPA supports the recommendations that girls require additional support to achieve optimal levels of PA, even at preschool age. This may drive the acquisition of fundamental movement skills which are key correlates of PA in this age group [8, 75].

Children who attended school for fewer hours each day (i.e. the younger children in the sample) were more active than their older counterparts. One explanation for this may be the greater opportunity that younger children have to be more active outside of the classroom setting. This differs to their older counterparts who at the age of 4–5 years were part of formal education and spent more time each day in a classroom-based learning environment, typically involving extended periods of sitting down. This finding may also be attributed to the age-specific cut-points used to interpret the PA data, which increase with age [43], though other studies have shown that age is not associated with activity levels in the preschool population and that differences may be related to the environmental factors [70, 74]. Interestingly, our results show that BMI, maternal education and child's ethnicity had no effect on ST and PA levels corresponding with other research investigating BMI [76] and SES [77] but not with ethnicity [71]. In summary, these findings are important as they highlight the influence of school, home and child-level covariates on children's PA levels, and the complexity of the process associated with changing behaviours, even during this early stage of life.

The limitations of this study include (i) the inclusion of the primary care giver in the intervention may have influenced the results, (ii) the inclusion of an activity log book during the time the children wore the accelerometer may have helped explain the types of activity the children engaged in outside of the sessions, (iii) a low 36% response rate during recruitment, (iv) the choice of accelerometer cut-points used has been criticized as being too high, specifically the MVPA thresholds [78] and (v) the sample used is not representative of all preschool children.

The strengths of this intervention lie in the delivery of the active play programme by experienced professionals and school personnel, and its flexible design which respected the autonomy of teachers to use the material outside of the weekly intervention sessions. Important strengths of this research are (i) the research design; the inclusion of a cluster randomized controlled trial with a relatively large sample size and the inclusion of a 6-month follow-up; (ii) both groups were matched for SES; (iii) the use of an objective measure of ST and PA and (iv) the use of multilevel analyses taking into account clustering of children within preschools.

Conclusion

Although the intervention was sufficiently intense, a 6-week active play programme was too short to accrue any changes in ST and PA engagement in the short and longer-term. Teachers and practitioners should be cautious when adopting structured PA programmes for use with preschool children. However, programmes such as active play are not likely to impart negative effects on young children's activity levels, when delivered in a developmentally appropriate way. To achieve public health goals, physical education programmes should promote PA during school time as well as outside of school.

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Conflict of interest statement

This study formed part of Mareesa O' Dwyer's doctoral programme of research.

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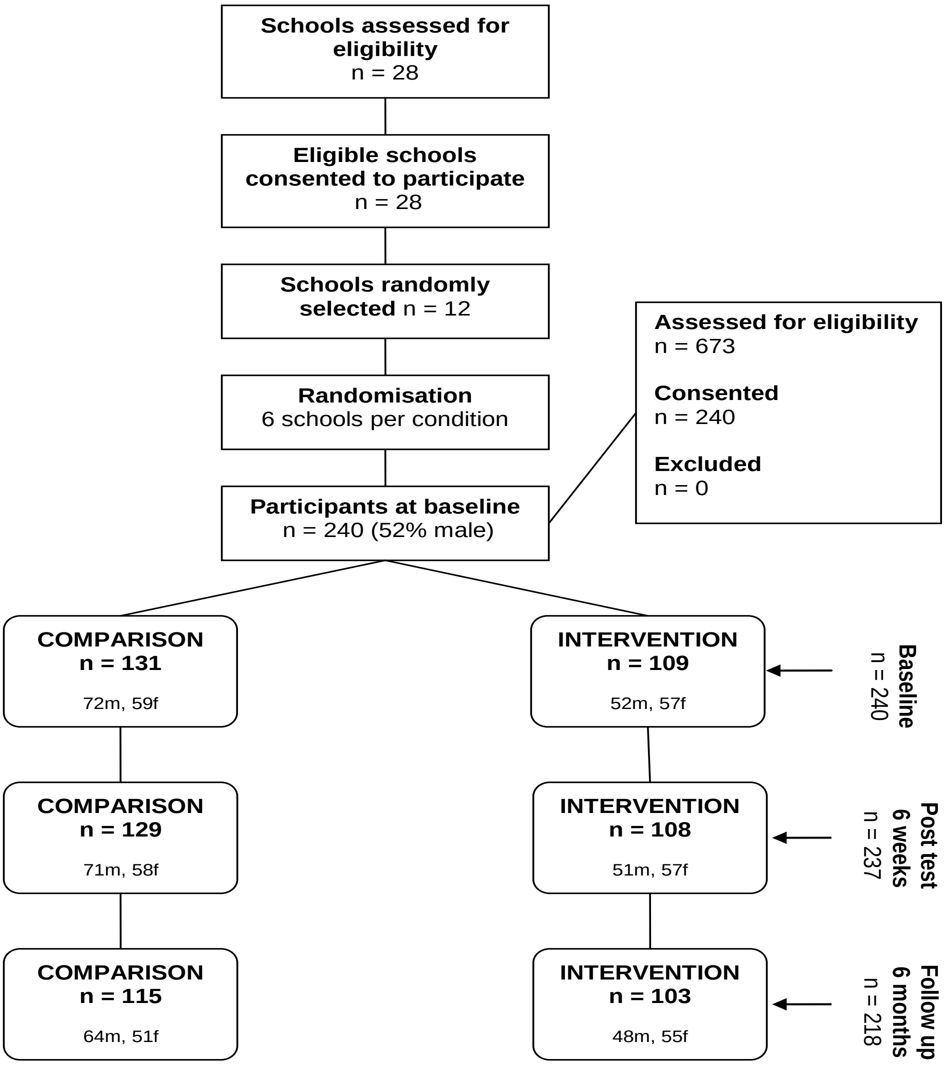

Figure 1 School and participant flow through the project

Table 1 Baseline unadjusted descriptive data for the sample (mean (SD))

	Intervention						Comparison					
	Boy Mean	SD	Girl Mean	SD	Total Mean	SD	Boy Mean	SD	Girl Mean	SD	Total Mean	SD
Age (y)	4.6	0.6	4.7	0.5	4.7	0.5	4.7	0.6	4.4	0.6	4.5	0.6
Stature(cm)	105.4	6.4	108.6	5.1	107.0	6.3	107.0	5.9	106.4	5.0	106.8	5.5
Mass (kg)	18.5	3.2	19.8	3.2	19.1	3.3	19.2	3.2	19.0	3.1	19.1	3.2
BMI(kgm^2)	16.7	1.8	16.6	1.7	16.7	1.7	16.7	1.8	16.8	1.9	16.7	1.9
%OW/OB	22.6		25.2		23.9		21.7		25.7		23.7	
Ethnicity §	85.0		82.9		84.3		70.6		80		75.3	

Notes: BMI standardised by age and sex (Cole, 2000), OW = overweight; OB = obese, § = reference: %white British, Values are mean (SD)

Table 2 Uncorrected mean minutes (SD) sedentary time, light and moderate-to-vigorous physical activity for all time points

		Baseline				**6 weeks**				**6 months**			
		INT (n=109)		**COM (n=131)**		**INT (n=108)**		**COM (n=129)**		**INT (n=103)**		**COM (n=115)**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ST	Boy	649.5	54.3	636.3	55.7	581.7	88.0	605.5	68.4	536.8	52.8	560.5	58.0
	Girl	645.5	56.1	625.2	60.8	608.1	77.6	585.9	76.1	525.7	56.5	557.5	55.5
LPA	Boy	69.1	13.9	70.8	11.0	68.5	16.5	70.3	13.0	59.9	15.1	58.7	15.1
	Girl	75.4	14.5	73.6	15.1	70.9	14.5	69.4	15.8	67.9	15.6	64.4	12.6
MVPA	Boy	45.2	17.7	40.3	15.2	46.5	19.2	37.5	15.1	35.8	16.6	32.4	12.6
	Girl	40.5	17.1	42.4	17.1	39.2	17.7	40.6	13.6	35.4	14.4	35.9	14.8

Data collected in North West England between September 2009 and December 2010. All values reported are in minutes.

Key: Int = intervention group; Com = comparison group; ST = sedentary time; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity

Table 3 Percentages (SD) of time spent participating in MVPA and Total PA during the Active Play session

	Intervention Sessions (n=30)		**Comparison Sessions** (n=30)	
	Mean	**SD**	**Mean**	**SD**
% MVPA	**31.3 (8.5)**	**8.5**	15.9 (6.3)	6.3
% Total PA	**45.2 (8.4)**	**8.4**	27.8 (8.8)	8.8

Data collected during week 3 of Active Play intervention. All values reported are in percentages. Key: Int = intervention group; Com =

comparison group; MVPA = moderate-to-vigorous physical activity; PA = physical activity. Bold faced text = P≤ .001

Table 4 Multilevel models: estimated effect of covariates and intervention "Active Play" on time spent being sedentary, in light physical activity and in moderate-to-vigorous physical activity from fully adjusted models

	ST (mins)		**LPA (mins)**		**MVPA (mins)**	
Parameter	**β**	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
Difference from baseline – post-test	7.9	-1.5 to 17.3	-0.1	-2.6 to 2.4	1.4	-2.1 to 4.9
Difference from post test – 6 month	-2.5	-12.5 to 7.5	-2.8	-5.5 to -0.1	-4.0	-7.7 to -0.3
Difference from baseline – 6 month	10.4	-0.4 to 21.2	2.8	-0.1 to 5.7	-5.4	-9.3 to -1.5
Intervention	3.6	-4.3 to 11.4	0.1	-2.1 to 2.3	-0.1	-3.0 to 2.84
Sex	**11.3**	**4.6 – 17.9****	**-3.2**	**-5.2 to -1.2****	-2.6	-5.3 to 0.1
Hours spent at school	**11.4**	**3.8 to 19.0****	-2.3	-4.7 to 0.1	**-6.2**	**-9.3 to -3.1*****
BMI – GM	-0.7	-2.26 to 1.26	0.7	0.1 to 1.3	0.4	-5.0 to 5.8
Wear time – GM	**0.8**	**0.60 to 0.99*****	0.1	-0.1 to 0.3	0.1	-0.1 to 0.3
Parents education						
Trade	6.4	-15.6 to 28.4	0.3	-6.4 to 7.0	-1.4	-10.2 to 7.4
University	1.0	-6.6 to 8.6	0.9	-1.5 to 3.3	1.3	-1.8 to 4.4
Ethnicity						
W/other	4.2	-11.0 to 19.1	-3.7	-8.2 to 0.8	-0.5	-6.6 to 5.6
Mixed race	-13.6	-27.9 to 0.7	-2.4	-6.7 to 1.9	1.9	-2.7 to 6.5

Asian	9.6	-10.0 to 29.2	-5.4	-11.3 to 0.5	-3.8	-11.4 to 4.2
B/ African	0.5 (11.2)	-21.5 to 22.5	1.9	-4.8 to 8.6	-2.4	-11.2 to 6.4
Other	16.0 (10.8)	-5.2 to 37.2	-4.5	-10.8 to 1.8	-2.1	-10.3 to 6.1
Random	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
School Level	29.1	28.9	0.8	2.1	2.0	3.9
Child Level	931.8	73.3	85.1	6.7	153.4	12.0
Time point Level	0.0	0.0	0.0	0.0	0.0	0.0
Deviance						
Crude Model	5660.45		3969.18		4088.69	
Adjusted Model	3424.52		2573.68		2782.56	

Note: Significant effects are indicated in bold: * P ≤ .05, **P ≤ .01, ***P≤ .001. Reference categories for intervention is comparison; for sex is boys; for hours spent at school is 3 hours; for parents education is did not complete high school; for ethnicity is white British. BMI and accelerometer wear time are reported as continuous variables where the average is centred around the grand mean (GM). The intervention β value represents the estimated difference in PA levels for the intervention schools against the comparison schools when all other parameters are included in the final model. The values presented for sex, hours at school, BMI, wear time, parents education and ethnicity are generated from the baseline – follow up analysis. A positive β value indicates a positive intervention effect on the PA levels of the intervention children compared with the comparison school children during the whole week over time. Abbreviations: β = Regression coefficient; SE = Standard Error; CI = Confidence Interval.