EFFECT OF A SIX WEEK ACTIVE PLAY INTERVENTION ON FUNDAMENTAL MOVEMENT SKILL COMPETENCE OF PRESCHOOL CHILDREN: A CLUSTER RANDOMISED CONTROLLED TRIAL [1,2,3 4]

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[2] Nicola Ridgers is supported by an Australian Research Council Discovery Early Career Researcher Award (DE120101173)
[3] Funding for the Active Play Project was provided by Liverpool Area Based Grants and the SportsLinx Programme and Liverpool John Moores University.
[4] We would like to thank our partners from Liverpool City Council/SportsLinx (Liz Lamb), the Active Play management (Pam Stevenson) and delivery team (Richard Jones, Adam Tinsley and Julie Walker), the Liverpool Early Years Team and the LJMU Physical Activity, Exercise and Health research group work bank volunteers who assisted with data collection and Carina Grünewald for her assistance with FMS analysis.

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Abstract

This study examined the effectiveness of an active play intervention on fundamental movement skills (FMS) amongst 3-5 year-old children from deprived communities. In a cluster randomized controlled trial design, six preschools received a resource pack and a six-week local authority program involving staff training with help implementing 60 minute weekly sessions and post-program support. Six comparison preschools received a resource pack only. Twelve skills were assessed at baseline, post-intervention and at a six-month follow-up using the Children's Activity and Movement in Preschool Study Motor Skills Protocol. One hundred and sixty two children (Mean age=4.64±0.58yrs; 53.1% boys) were included in the final analyses. There were no significant differences between-groups for total FMS, object-control or locomotor skill scores, indicating a need for program modification to facilitate greater skill improvements.

Fundamental movement skills (FMS) are the building blocks of more complex movements and fall into three categories; stability (e.g. balancing and twisting), locomotor (e.g. running and jumping) and object-control (e.g. catching and throwing) (Gallahue & Donnelly, 2003). Developing competence in FMS is important (Robinson et al., 2015; Stodden et al., 2008), as high competence has been associated with increased physical activity (Logan, Webster, Getchell, Pfeiffer, & Robinson, 2015), cardio-respiratory fitness (Vlahov, Baghurst, & Mwavita, 2014), academic achievement (Jaakkola, Hillman, Kalaja, & Liukkonen, 2015) and reduced prevalence of overweight and obesity (O' Brien, Belton, & Issartel, 2016; Rodrigues, Stodden, & Lopes, 2015).

Early childhood (age 2-5 years) is seen as a "window of opportunity" for FMS development due to rapid brain growth and neuromuscular maturation (Malina, Bouchard, & Bar-Or, 2004), alongside high levels of perceived competence (LeGear et al., 2012). When given necessary opportunities and appropriate encouragement, children have the developmental capability to achieve mature performance of FMS by age six (Gallahue & Donnelly, 2003). However, studies from England (Foulkes et al., 2015) and internationally (Barnett, Ridgers, & Salmon, 2015; D. P. Cliff, Okely, Smith, & McKeen, 2009; Goodway, Robinson, & Crowe, 2010; Hardy, King, Farrell, Macniven, & Howlett, 2010; Robinson, 2011; Ulrich, 2000) report low levels of FMS competence among preschool and primary age children. Furthermore, children from areas of high deprivation typically have subordinate levels of FMS development compared to children residing in areas of low deprivation (Goodway et al., 2010; Morley, Till, Ogilvie, & Turner, 2015). Given sub-optimal levels of FMS competence and evidence that low FMS tracks over time (Hardy, King, Espinel, Cosgrave, & Bauman, 2010; O'Brien, Issartel, & Belton, 2013), there is a clear need for interventions to improve FMS, especially amongst young children living in deprived areas.

While all children develop a rudimentary fundamental movement pattern over time, mature patterns of FMS do not develop "naturally" (Clark, 2005). Rather, for these skills to develop, instruction and practice are required (Payne & Isaacs, 2002). In a systematic review of motor development interventions among young children, Riethmuller, Jones, and Okely (2009) found that almost 60% of 17 studies included observed statistically significant improvements in FMS competency at follow up, but only three studies were deemed to be of high methodological quality

(Connor-Kuntz & Dummer, 1996; Ignico, 1991; Reilly et al., 2006). This review was recently updated by Veldman, Jones, and Okely (2016) who identified seven additional studies. Six studies reported positive intervention effects on FMS performance, with five of these interventions delivered by setting staff. However, both reviews reported that none of these studies evaluated the effectiveness of interventions on FMS among young children from England. Additionally, there is limited research targeting children from areas of high deprivation. Goodway and Branta (2003) examined the effect of a twelve-week researcher-led motor skill intervention in disadvantaged American preschool children. Compared to controls, children in the intervention group had significantly higher locomotor and object-control skill scores post-intervention, offering evidence that interventions for deprived children can improve FMS competency.

The aim of this study was to examine the effectiveness of a six-week Active Play intervention on FMS competency in 3-5 year old children from a deprived area of England (Department of Communities and Local Government, 2010). The Active Play program was designed and implemented by Liverpool City Council (i.e., local Government). It was developed in response to data collected from 9-10 year olds which revealed low levels of physical activity and fitness, and high levels of sedentary behavior and obesity (Boddy, Hackett, & Stratton, 2009; Fairclough, Boddy, Hackett, & Stratton, 2009; Stratton et al., 2007; Stratton et al., 2009), indicating a need for beginning interventions in early childhood. The intervention involved professional development for preschool educators (i.e. teachers and teaching assistants) in order for them to deliver a curriculum of developmentally appropriate physical activity within the preschool setting. Results from a cluster-randomized controlled trial to determine the effects of the Active Play Project on physical activity and sedentary behavior outcomes were previously reported (O'Dwyer et al., 2013). This study aims to report the effect of the Active Play program on FMS. We hypothesized that participation in the intervention would result in significantly higher FMS levels at post-test and at six-month follow up, when compared to a comparison resource package condition with no teacher training or implementation support. Sex interaction effects were explored given reported sex differences in fundamental movement skill competence (Foulkes et al., 2015; Goodway et al., 2010; Hardy, King, Farrell, et al., 2010; Robinson, 2011).

Method

Study design, participants and settings

This research design and reporting followed the guidelines in the Template for Intervention Description and Replication (TIDieR) (Hoffmann et al., 2014) and Consolidated Standards of Reporting Trials (CONSORT) (Campbell, Piaggio, Elbourne, & Altman, 2012). A cluster randomized controlled trial was conducted to evaluate the effect of a six-week Active Play educational program on children's physical activity levels, sedentary behavior and fundamental movement skill competency. Ethical approval for the project was granted by the University Ethics Committee (Reference 09/SPS/027). The trial occurred across two academic years (from October 2009 to November 2010) to maximise recruitment and to minimize the influence of seasonal variation (Carson & Spence, 2010; Rich, Griffiths, & Dezateux, 2012). Assessments were conducted at baseline, immediately following the six-week Active Play intervention and again at a six-month follow-up (see Table 1).

Insert Table 1 Here

In line with the project funding requirements, the 12 preschools within Liverpool (a large urban city in Northwest England) attached to a Surestart children's center were invited to take part in the study. SureStart children's centers provide advice, support and delivery of services to parents and carers of children aged five years or under who are living in the most disadvantaged parts of England (Children, Schools and Families Committee, 2010). At the time of this study, each of the 12 preschools were situated within neighbourhoods ranked in the most deprived decile for deprivation nationally (Department of Communities and Local Government, 2010). All 12 preschools agreed to take part in the study, with six allocated to Phase 1 (Academic Year 1) and the remaining six allocated to Phase 2 (Academic Year 2). Preschools were randomly allocated to either the intervention (n = 6) or comparison (n = 6) group. Randomization was achieved by having a member of the research team draw folded sheets of paper (each marked with a preschool's code) from a hat. Allocation alternated between groups, with the first, third and fifth preschool placed into the intervention group. This randomization procedure has been deemed acceptable for samples of $n \leq 60$ (Portney & Watkins, 2000). Neither participants nor researchers were blinded to the experimental group, with the exception of the researcher undertaking video assessment of FMS competency.

All children aged 3-4.9 years attending the twelve preschools were invited to participate in the study (n = 673). At the time of the study, all three and four year old children in England were eligible to receive 15 hours of free preschool education for 38 weeks of the year. Four year old children were either attending under this offer or had recently commenced full time compulsory education (i.e., Monday to Friday, between the hours of 09:00 and 15:00). Active consent was mandatory for those wishing to participate; parents provided informed written consent, demographic information (home postcode, child ethnicity and child's date of birth) and completed medical assessment forms. All invited children were eligible to participate, however, children who, by parental self-report, had previously been diagnosed with health or co-ordination issues that could affect their motor development were excluded from the analysis.

Intervention

Preschools randomized to the intervention group received the full Active Play Program, which included professional development for staff, session delivery, post-program support, and an Active Play resource pack. The Active Play program was a service provided by the Sport and Leisure Directorate of Liverpool City Council. Active Play aimed to increase young children's physical activity, FMS competency, self-confidence, strength, agility, co-ordination and balance (strength, agility, coordination and balance were not measured as part of the scientific evaluation). The intervention was designed by an expert in program delivery (a former Physical Education teacher who has written and delivered inclusive resources and training packages for the Youth Sports Trust, Sports Coach UK, the English Federation of Disability Sport and major companies), and implemented by a team of three Active Play practitioners. These practitioners held several sports coaching qualifications, had attended professional development workshops on delivering active play program, and had accumulated over 10 years of coaching experience between them.

The intervention was designed using elements of the socio-ecological model (Brofenbrenner, 1979; Brofenbrenner & Morris, 1998, 2006; Copeland, Kendeigh, Saelens, Kalkwarf, & Sherman, 2012) and targeted known mediators and moderators in the child's social environment (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008). Specifically, the intervention identified that the child's teacher and preschool environment were key components for physical activity promotion and program sustainability, and targeted them accordingly. Early childhood educators have previously indicated that they would benefit from more training around physical activity and movement skill activities that could be implemented in preschool environments (Gehris, Gooze, & Whitaker, 2015; Tucker, van Zandvoort, Burke, & Irwin, 2011). Thus, the intervention was structured around the provision of staff development opportunities and on-going support for preschool educators (i.e., teachers and teaching assistants).

In order to fit with the school calendar and local authority budget, each intervention preschool received weekly Active Play sessions lasting up to 60 minutes for a six-week period (~360 minutes in total). These Active Play sessions were delivered as part of an educational program aimed at staff and children within the preschool setting, and followed a 2-2-2 delivery approach. Model instruction from a Local Authority Active Play practitioner occurred for the first two weeks of the program (with the preschool staff observing), followed by co-instruction between preschool staff and the Active Play practitioner for two weeks. For the final two weeks, preschool staff independently instructed sessions with the support of the Active Play practitioner. This type of experiential learning is a process through which the learner (i.e., the preschool educator) is able to construct knowledge, skill and value directly from an experience within the environment (Marlow & McLain, 2011). In order to support staff implementing the intervention, preschools also received a comprehensive Active Play resource pack, which was aligned with the principles of the UK preschool curriculum (Department for Children, Schools and Families, 2008). It consisted of 20 activity cards (see Table 2), a user manual containing topics such as "Getting Activity at the Right Level" and "Including all Children", sample lesson plans, signposting information to useful online/print resources and information sources and a A3 poster that promoted active play. At the end of the six-week intervention, preschool staff were encouraged to continue with independent delivery and integrate the program into current practice. Additionally, preschool staff received an on-demand email and telephone service for additional support, where necessary, while the program was ongoing. This included ideas for additional games or assisting with active fun days. The Active Play program was disbanded in 2012 due to Government funding cuts and is no longer publically available.

Insert Table 2 Here

Comparison

Due to the length of the planned follow up (6 months) and comparison schools' interest in the initiative, comparison schools received the Active Play resource pack after baseline assessments had been completed. However, no professional development, session delivery or post-program support were provided. Further, comparison preschools were instructed to continue with their existing physical activity curriculum. At the time of the project, the Early Years Foundation Stage Curriculum (Department for Children, Schools and Families, 2008) guidelines placed an emphasis on play-based learning and development in six main areas (personal, social and emotional development; communication, language and literacy; problem solving, reasoning and numeracy; knowledge and understanding of the world; physical development, and creative development).

Measures

Fundamental Movement Skills.- FMS were examined using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000) protocol. The TGMD-2 was specifically designed and validated to be used in the assessment of FMS among children aged 3-10 years (Ulrich, 2000). The TGMD-2 measures the competency of 12 FMS, six locomotor (run, broad jump, leap, hop, gallop and slide) and six object-control (overarm throw, stationary strike, kick, catch, underhand roll and stationary dribble) skills. A senior member of the research team with significant experience in administering the TGMD-2 was responsible for training all field testers, via *in-situ* observation, prior to the start of data collection. Dependent on the facilities available, assessments took place in either school halls or outside on school playgrounds, with children in small groups of between two and four, led by two field testers. The first tester was responsible for providing a verbal description and single demonstration of the skill required, while the second recorded each trial using a tripod mounted video camera (Sanyo, Japan). In cases where a child did not understand the task they were being asked to complete (e.g. they ran in the wrong direction), a further verbal description and demonstration of the skill was given and they repeated the trial. Children performed each skill twice. All 12 skills were completed in the same order, taking approximately 35-40 minutes per group.

Video recordings of children's FMS were converted to DVD, allowing video analysis to take place at a later date. The Children's Activity and Movement in Preschool Study Motor Skills Protocol (CMSP; (Williams et al., 2009) was chosen to assess FMS competency. The CMSP is a process-oriented assessment, evaluating each skill based upon the demonstration of specific movement components (Williams et al., 2009), such as *"arms move downward during landing"* for the jump (see Tables 1 and 2 of (Williams et al., 2009). Whilst developed using an identical protocol to the TGMD-2 (Ulrich, 2000), the CMSP provides improved assessment sensitivity due to its additional performance criteria and alternative scoring methods (Williams et al., 2009). Furthermore, the CMSP has demonstrated high reliability (R=0.94), inter-observer reliability (R=0.94) and concurrent validity when compared to the TGMD-2 (R=0.98) (Williams et al., 2009).

All analyses were completed by a single trained assessor, following 30 hours of training from a member of the research team experienced in undertaking video assessment of FMS. Interrater reliability was established through the use of pre-coded DVDs of 10 children undertaking the TGMD-2 protocol, with an 83.9% agreement found across the 12 skills (range 72.9-89.3%) for the individual components of each skill. Intra-rater reliability was further established using pre-coded DVDs of a further 10 children, with test-retest taking place one week apart. This resulted in a 91.9% agreement for the 12 skills (range 89-96%). Despite there being no accepted minimum level of percentage agreement, 80-85% agreement has previously been deemed as acceptable (van der Mars, 1989). If unsure whether a child had met a performance criterion, the footage was reviewed by the assessor and the experienced researcher, with a final decision on scoring agreed between the two.

Individual skill components (ranging from 3-8, dependent on the skill) were marked as absent (0) or present (1) for both trials of each skill. If a skill component was successfully demonstrated across both trials, then it was classed as present. Exceptions to this scoring system were present in components 4 and 5 of the overhand throw and strike, where hip/trunk rotation was scored as differentiated (2), block (1) or no rotation (0). Additionally the catch identifies a successful attempt as either being *"caught cleanly with hands/fingers"* (2) or *"trapped against body/chest"* (1). In accordance with the outcome measures of the CMSP (Williams et al., 2009), the number of individual skill components classed as being present were summed to create a total score. Likewise, locomotor and object-control scores were created by summing the number of present components within each subscale.

Anthropometry.- Body mass (to the nearest 0.1 kg) and stature (to the nearest 0.1 cm) were measured onsite using calibrated digital scales (Tanita WB100-MA, Tanita Europe, The Netherlands) and a portable stadiometer (Leicester Height Measure, SECA, Birmingham, UK), respectively. Body mass index (BMI, kg/m^2) was calculated and converted to BMI z-scores (Cole, Bellizzi, Flegal, & Dietz, 2000).

Analysis.-Descriptive data were analyzed using SPSS v22.0 (IBM Corporation, New York). Descriptive statistics were calculated by sex and random group assignment (comparison or intervention) to describe the baseline characteristics of participating children, including weight categorization (Cole et al., 2000) and deprivation level (Department of Communities and Local Government, 2010). Independent t-tests were used to assess group differences at baseline, with the exception of the proportion of children within the most deprived decile for deprivation, which was analyzed using a chi-square test. An intention to treat analysis was used, whereby all participants that completed FMS assessments at baseline and subsequently participated in either post-test or follow-up measurements were included in the respective analyses.

MLwiN v2.30 (Center for Multilevel Modelling, University of Bristol, UK) was used to perform the main analysis, which comprised of multilevel linear regression analyses to examine intervention effects on the dependent variables (total, locomotor and object-control scores). Multilevel models effectively analyze the hierarchical nature of non-independent, nested data by taking into account the dependency of observations (Goldstein, 1995). A 2-level data structure was used to account for children being nested within their individual schools, whereby children were classed as being the first level unit of analysis, with preschool the second. Analysis of the intervention effects between baseline and post-test, and baseline and follow-up were conducted separately (Twisk, 2006). Initially, a 'crude' analysis determined the intervention effect adjusting for baseline dependent variable score only, whilst the second analysis 'adjusted' for sex, baseline decimal age and BMI z-score (Barnett, Van Beurden, Morgan, Brooks, & Beard, 2010; Clark, 2005; Dylan P. Cliff et al., 2012; Goodway et al., 2010; Jones, Okely, Caputi, & Cliff, 2010). Additionally, sex interactions were explored in order to determine whether the intervention effects differed between boys and girls. Regression coefficients in each model were assessed for significance using the Wald statistic with one degree of freedom. Statistical significance was set at $p<0.05$, and at $p<0.10$ for the sex interaction term.

Results

Figure 1 details the flow of participants through the study. In total, 162 children (68%) from the 240 who provided full parental consent met the inclusion criteria for this study (i.e., complete baseline data for age, BMI, gender and FMS) and were subsequently included in the final analysis. Participant retention ranged from 89% (post-test) to 63% (follow up) in the control group, while the intervention group's retention rate ranged from 73% (post-test) to 86% (follow up). Missing or incomplete FMS data was due to children being absent on testing days or having to return to class on instruction from their teacher in order to complete curricular activities.

Insert Figure 1 Here

Baseline characteristics for the study participants (*M* age 4.64 yr., *SD* = 0.58; 53.1 % boys; 25.3% overweight/obese; 80.8% White British; 93.4% lived in a low socio-economic area) are shown in Table 3. Competency levels were found to be low for all children at baseline, especially for object-control skills, although children within the intervention group had significantly higher total (t (160) = -2.16, p = 0.03) and object-control scores (t (160) = -2.32, p = 0.03) in comparison to children within the control group. Boys within the intervention group had a significantly higher (t (84) = -2.0, p = 0.04) total FMS score than comparison boys at baseline, while intervention girls had a significantly higher object-control score (t (74) = -2.01, p = 0.04) than comparison girls at baseline.

Insert Table 3 Here

Intervention Effects

No significant intervention effects on total, object-control or locomotor scores between baseline and post-test or baseline and follow-up (see Table 4) were observed. However, small, potentially practically meaningful, positive intervention effects were noted for total (β = 1.45, 95% CI -0.34 to 3.24, p = 0.11) and object-control (β = 1.01, 95% CI -0.22 to 2.24, p = 0.11) scores in the adjusted model between baseline and post-test, though any positive effects had diminished at follow-up.

Insert Table 4 Here

Sex Interaction Effects

Table 5 shows the results of the sex interaction analyses between baseline and post-test and baseline and follow-up. Between baseline and post-test, a significant interaction (p=0.09) was observed for locomotor score in the crude analysis, but this was attenuated after adjusting for covariates. No other significant sex interactions were observed.

Insert Table5 Here

Discussion

This is the first randomized controlled trial to examine the effectiveness of an FMS intervention amongst English preschool children from deprived communities. Compared to the comparison group, the local Government designed and implemented six-week Active Play intervention in preschool settings had no significant effects on total, locomotor or object-control FMS score at either post-test or six-month follow-up. While this intervention was effective at increasing the proportion of time that children spent active during the Active Play sessions (O'Dwyer et al., 2013), the program design and its components did not support significant developments in children's FMS.

These findings indicate that the program did not significantly increase FMS scores, though a trend was observed for beneficial effects on locomotor skills in girls. There may be a number of reasons for these results. One is a relatively short program duration, whereas two recent systematic reviews reported that the majority of effective programs ran for two months or longer (Riethmuller et al., 2009; Veldman et al., 2016). The frequency and volume of training in these different programs is also important. Donath, Faude, Hagmann, Roth, and Zahner (2015) reported significant improvements in skill competency following a six-week intervention, but sessions were delivered twice weekly and were focused on object-control skills only. Further, specialist sports coaches delivered the intervention, a fact that has practical implications for delivering programs at scale and over the longer term. Nevertheless, taken together these results suggest that a greater dose of the 'Active Play' program might have led to significant improvements in young children's FMS.

Other factors may have also contributed to the lack of substantial program effects on FMS, including staff training components (Dwyer, Higgs, Hardy, & Baur, 2008), staff's prior experiences (Derscheid, Umoren, Kim, Henry, & Zittel, 2010), the quality of delivery, and the program curriculum (Bellows, Anderson, Gould, & Auld, 2008). The intervention included a 2-2-2 week experiential learning training model that began with Active Play specialists delivering the program and ended with the preschool staff independently delivering sessions. Within existing literature, there is no clear consensus on the training required to effectively upskill preschool staff to improve children's FMS competence. However, lessons could be learned from recent successful interventions that utilized either a one-day workshop (Hardy, King, Kelly, Farrell, & Howlett, 2010; Piek et al., 2013) or a series of brief workshops (Jones et al., 2011). Unlike the Active Play program, these occurred prior to program implementation, and included a blend of practical and theoretical components – the latter may have been useful in indoctrinating preschool educators' into the Active Play program philosophy and enhancing their knowledge and understanding of the program content. Whilst the present study did not incorporate measurement of intervention fidelity, the absence of intervention effects at six-month follow-up indicates that preschool staff may not have integrated the program within their existing practice. The Active Play specialist practitioners did offer an on-demand support service for preschool staff after the initial six-week program but more structured support, such as mentoring or direct supervision, or opportunities for collaboration with peers (e.g. communities of practice), could be considered by program planners.

It is also possible that the Active Play curriculum, which targeted physical activity, sedentary behavior and 12 different FMS, was too broad in scope, particularly given the short duration of the intervention. For example, the intervention reported by Jones et al. (2011) focused on only five skills over a longer period of time and was able to bring about greater improvements in competency. It is important to note that the Active Play program was, however, effective at increasing levels of moderate-to-vigorous physical activity during sessions (O'Dwyer et al., 2013). The curriculum activities and resource cards were designed to provide opportunities for children to explore and try different FMS while engaging in moderate-to-vigorous physically active play. However, young children may require more targeted and focused skill-development activities, with approaches utilizing direct instruction, guided discovery or deliberate practice alongside the provision of positive feedback (Donath et al., 2015; Draper, Achmat, Forbes, & Lambert, 2012; Gallahue & Donnelly, 2003; Goodway, Crowe, & Ward, 2003; Jones et al., 2011; Payne & Isaacs, 2002).

The strengths of this cluster-randomized controlled trial include both its design and the use of a validated process-based measure of FMS, assessed using video analysis by a researcher blinded to the group allocation. Further, the study included a follow-up assessment that allowed an examination of long-term program effects. A lack of follow-up data has been a noted limitation of previous studies e.g. (Lai et al., 2014; Riethmuller et al., 2009). A limitation of the present study was the 68% participation rate at baseline of children eligible to take part (*n* = 240) and the further decreases in participant numbers at post-test and follow-up due to children leaving school and incomplete FMS data. Such problems highlight common data collection difficulties when studying young children within a preschool environment.

This is the first study to examine the effectiveness of an intervention to promote FMS competency among young children from England. Despite the lack of significant effects of the Active Play intervention on FMS competency among young children from deprived areas, our findings have important implications for research and practice. The results suggest that this Active Play intervention may have needed to run for longer and/or with a greater frequency of session delivery in order to be effective. Future research focusing on questions related to appropriate intervention, duration/dosage, effective training for setting staff, and greater instruction and practice of FMS will help to further inform the design and implementation of future FMS interventions.

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Table 1. Active Play project timeline.

	Data Collection and Intervention Delivery			
	Baseline	**6 Week Intervention**	**Post-Test**	**Follow Up**
Phase 1	Oct 2009	Oct – Nov 2009	Dec 2009	July 2010
Phase 2	Mar 2010	Apr – May 2010	Jun 2010	Nov 2010

Table 2. Description of example Active Play cards.

Card	Content
Warming up: Exploring bodies	Introduce children to warming their bodies up for activity and explore body parts. Children move around like buzzing bees, when the sound cue is given they touch a body part.
Dance: Free flow and motifs	Explore dance and movement using stories, combining a chorus where the group moves together and verses where the children explore and express themselves.
Gym: Jumping gym	Explore different ways of jumping. Children participate in bunny hops and standing jumps. Introduce a rope on the floor to make the activity more difficult.
Games: Sending with accuracy (targets)	Explore precision and co-ordination. Practice target games individually, in pairs, or as a group. e.g. draw targets on walls and aim for your favourite e.g. different fruits
Cool down: Child on child massage	Introduce children to positive touch through massage, whilst cooling their bodies down after exercise

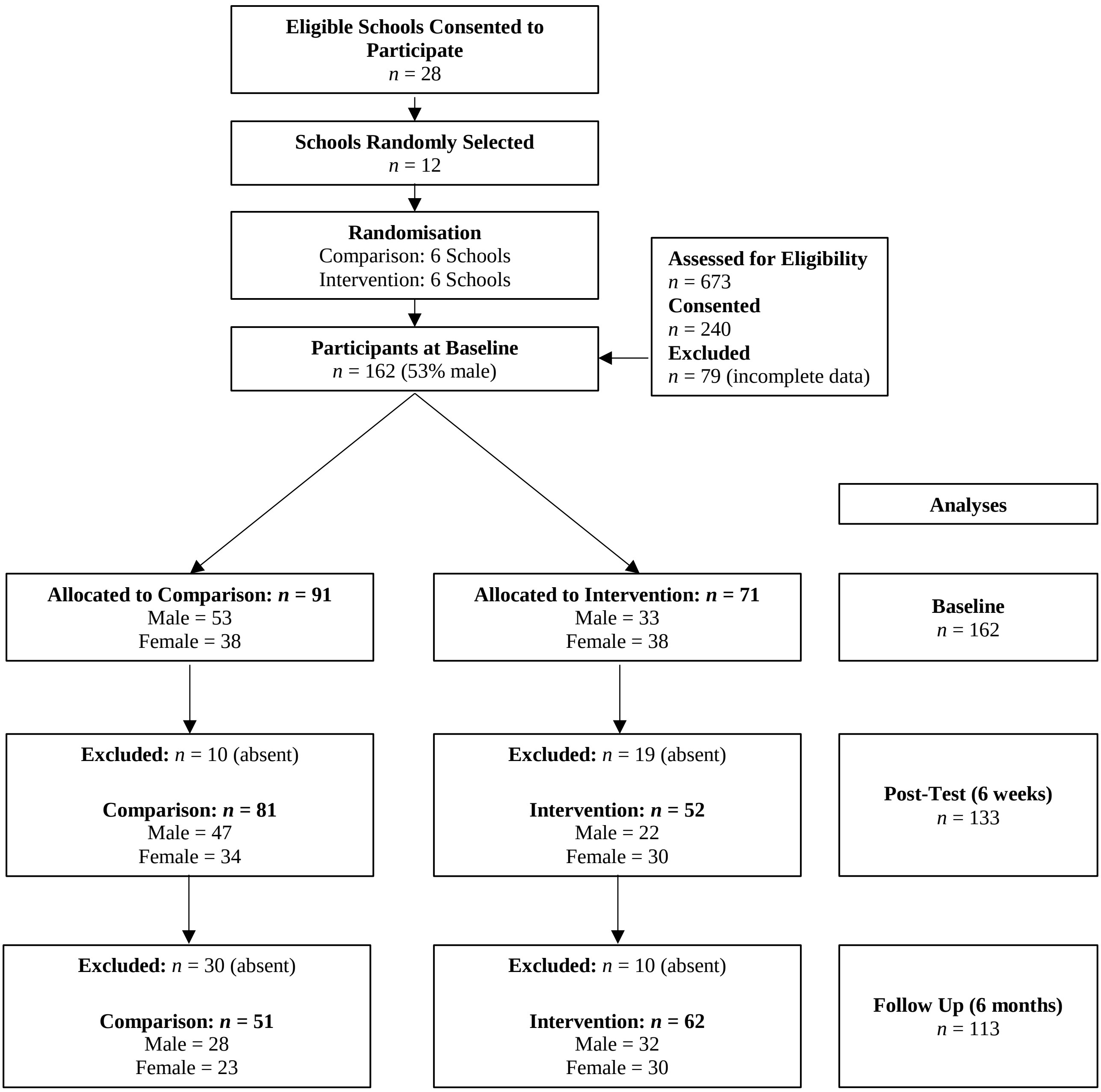

Figure 1. Flowchart of schools and particpants through the study.

Table 3. Baseline descriptive characteristics for intervention and comparison children (Mean ± SD).

Measure	Comparison (n=6 preschools)			Intervention (n=6 preschools)		
	Boys (n=53)	**Girls (n=38)**	**Total (n=91)**	**Boys (n=33)**	**Girls (n=38)**	**Total (n=71)**
Age (yrs)	4.7±0.6	4.5 ±0.6	4.6 ±0.6	4.7 ±0.7	4.7±0.5	4.7±0.6
Stature (cm)	108.7±6.2	105.9±5.7	107.6±6.1	107.4± 5.5	107.6±4.8	107.8±5.1
Body Mass (kg)	19.9±3.7	18.7 ±3.1	19.4 ±3.5	19.3 ±2.9	19.1 ±2.5	19.2 ±2.7
BMI (kg/m^2)	16.7 ±1.7	16.7±1.8	16.7±1.8	16.7 ±1.6	16.5±1.4	16.6 ±1.5
IMD (%)[†]	90.0	91.7	90.7	96.8	97.1	97.0
Total FMS[‡]	26.2± 7.1	25.8 ±6.6	26.1 ±6.9	29.4 ±7.1	27.5 ±5.9	28.4 ±6.5
Object-Control Score[‡]	11.1±4.2	9.2±3.1	10.3±3.9	12.8±4.2	10.7±3.4	11.7±3.9
Locomotor Score[‡]	15.2±3.9	16.7±4.4	15.8±4.2	16.6±4.3	16.8±3.6	16.7±3.9

†Indices of Multiple Deprivation score; percentage of children living within the highest tertile for deprivation. ‡Maximum attainable score: Total FMS score 73; object-control skill score 39; and locomotor skill score 34.

Table 4. Multilevel analysis of the effectiveness of the Active Play Project intervention on fundamental movement skills between baseline and post-test, and baseline and six month follow-up.

	Crude Model[a]		**Adjusted Model[b]**	
Outcome Measure	**β (95% CI)**	***p***	**β (95% CI)**	***p***
Post-Test				
Total FMS	1.40 (-0.37, 3.17)	0.12	1.45 (-0.34, 3.24)	0.11
Object-control skills	0.73 (-0.51, 1.97)	0.24	1.01 (-0.22, 2.24)	0.11
Locomotor skills	0.57 (-0.82, 1.96)	0.42	0.46 (-0.9, 1.82)	0.80
Follow-Up				
Total FMS	0.21 (-1.83, 2.25)	0.84	0.31 (-1.31, 1.93)	0.71
Object-control skills	0.33 (-1.56, 2.22)	0.73	0.48 (-1.07, 2.03)	0.55
Locomotor skills	0.29 (-0.72, 1.3)	0.57	0.12 (-0.93, 1.17)	0.82

Note.– β = beta coefficient. CI = confidence intervals. [a]Adjusted for baseline score.[b]Further adjusted for sex, BMI-z score and and age.

Table 5. Multilevel analysis exploring interaction effects by sex between baseline and post-test and baseline and six month follow-up.

Outcome Measure	**Intervention*gender[a] (crude model)**		**Boys[b]**		**Girls[b]**	
	β (95% CI)	***p***	**β (95% CI)**	***p***	**β (95% CI)**	***p***
Post-Test						
Total FMS	1.18 (-2.36, 4.72)	0.51	n/a	n/a	n/a	n/a
Object-control skills	-0.83 (-3.24, 1.58)	0.48	n/a	n/a	n/a	n/a
Locomotor skills	1.84 (-0.33, 4.01)	0.09*	-0.51 (-2.26, 1.24)	0.57	1.36 (-0.34, 3.06)	0.12
Follow-Up						
Total FMS	-1.07 (-4.28, -2.14)	0.51	n/a	n/a	n/a	n/a
Object-control skills	-1.63 (-4.18, 0.92)	0.21	n/a	n/a	n/a	n/a
Locomotor skills	0.48 (-0.96, 2.96)	0.63	n/a	n/a	n/a	n/a

Note. - β = beta coefficient. CI = confidence intervals.[a]Adjusted for baseline score. [b]Further adjusted for BMI-*z* score and age. n/a = no significant interaction, follow up analyses not concducted.*Significant difference (p<0.1).