

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.

18 Fundamental movement skills (FMS) are the building blocks of more complex movements
19 and fall into three categories; stability (e.g. balancing and twisting), locomotor (e.g. running and
20 jumping) and object-control (e.g. catching and throwing) (Gallahue & Donnelly, 2003). Developing
21 competence in FMS is important (Robinson et al., 2015; Stodden et al., 2008), as high competence has
22 been associated with increased physical activity (Logan, Webster, Getchell, Pfeiffer, & Robinson,
23 2015), cardio-respiratory fitness (Vlahov, Baghurst, & Mwavita, 2014), academic achievement
24 (Jaakkola, Hillman, Kalaja, & Liukkonen, 2015) and reduced prevalence of overweight and obesity
25 (O' Brien, Belton, & Issartel, 2016; Rodrigues, Stodden, & Lopes, 2015).

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

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

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

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

74

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Method

76

77 *Study design, participants and settings*

78 This research design and reporting followed the guidelines in the Template for Intervention

79 Description and Replication (TIDieR) (Hoffmann et al., 2014) and Consolidated Standards of

80 Reporting Trials (CONSORT) (Campbell, Piaggio, Elbourne, & Altman, 2012). A cluster randomized

81 controlled trial was conducted to evaluate the effect of a six-week Active Play educational program on

82 children's physical activity levels, sedentary behavior and fundamental movement skill competency.

83 Ethical approval for the project was granted by the University Ethics Committee (Reference

84 09/SPS/027). The trial occurred across two academic years (from October 2009 to November 2010) to

85 maximise recruitment and to minimize the influence of seasonal variation (Carson & Spence, 2010;

86 Rich, Griffiths, & Dezateux, 2012). Assessments were conducted at baseline, immediately following

87 the six-week Active Play intervention and again at a six-month follow-up (see Table 1).

88

89

Insert Table 1 Here

90

91 In line with the project funding requirements, the 12 preschools within Liverpool (a large

92 urban city in Northwest England) attached to a Surestart children's center were invited to take part in

93 the study. SureStart children's centers provide advice, support and delivery of services to parents and

94 carers of children aged five years or under who are living in the most disadvantaged parts of England

95 (Children, Schools and Families Committee, 2010). At the time of this study, each of the 12

96 preschools were situated within neighbourhoods ranked in the most deprived decile for deprivation

97 nationally (Department of Communities and Local Government, 2010). All 12 preschools agreed to

98 take part in the study, with six allocated to Phase 1 (Academic Year 1) and the remaining six allocated

99 to Phase 2 (Academic Year 2). Preschools were randomly allocated to either the intervention (n = 6)

100 or comparison (n = 6) group. Randomization was achieved by having a member of the research team

101 draw folded sheets of paper (each marked with a preschool's code) from a hat. Allocation alternated

102 between groups, with the first, third and fifth preschool placed into the intervention group. This
103 randomization procedure has been deemed acceptable for samples of $n \leq 60$ (Portney & Watkins,
104 2000). Neither participants nor researchers were blinded to the experimental group, with the exception
105 of the researcher undertaking video assessment of FMS competency.

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

116

117 *Intervention*

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

130 The intervention was designed using elements of the socio-ecological model (Brofenbrenner,
131 1979; Brofenbrenner & Morris, 1998, 2006; Copeland, Kendeigh, Saelens, Kalkwarf, & Sherman,
132 2012) and targeted known mediators and moderators in the child’s social environment (Hinkley,
133 Crawford, Salmon, Okely, & Hesketh, 2008). Specifically, the intervention identified that the child’s
134 teacher and preschool environment were key components for physical activity promotion and program
135 sustainability, and targeted them accordingly. Early childhood educators have previously indicated
136 that they would benefit from more training around physical activity and movement skill activities that
137 could be implemented in preschool environments (Gehris, Gooze, & Whitaker, 2015; Tucker, van
138 Zandvoort, Burke, & Irwin, 2011). Thus, the intervention was structured around the provision of staff
139 development opportunities and on-going support for preschool educators (i.e., teachers and teaching
140 assistants).

141 In order to fit with the school calendar and local authority budget, each intervention preschool
142 received weekly Active Play sessions lasting up to 60 minutes for a six-week period (~360 minutes in
143 total). These Active Play sessions were delivered as part of an educational program aimed at staff and
144 children within the preschool setting, and followed a 2-2-2 delivery approach. Model instruction from
145 a Local Authority Active Play practitioner occurred for the first two weeks of the program (with the
146 preschool staff observing), followed by co-instruction between preschool staff and the Active Play
147 practitioner for two weeks. For the final two weeks, preschool staff independently instructed sessions
148 with the support of the Active Play practitioner. This type of experiential learning is a process through
149 which the learner (i.e., the preschool educator) is able to construct knowledge, skill and value directly
150 from an experience within the environment (Marlow & McLain, 2011). In order to support staff
151 implementing the intervention, preschools also received a comprehensive Active Play resource pack,
152 which was aligned with the principles of the UK preschool curriculum (Department for Children,
153 Schools and Families, 2008). It consisted of 20 activity cards (see Table 2), a user manual containing
154 topics such as “Getting Activity at the Right Level” and “Including all Children”, sample lesson plans,
155 signposting information to useful online/print resources and information sources and a A3 poster that
156 promoted active play. At the end of the six-week intervention, preschool staff were encouraged to
157 continue with independent delivery and integrate the program into current practice. Additionally,

158 preschool staff received an on-demand email and telephone service for additional support, where
159 necessary, while the program was ongoing. This included ideas for additional games or assisting with
160 active fun days. The Active Play program was disbanded in 2012 due to Government funding cuts and
161 is no longer publically available.

162

163 *Insert Table 2 Here*

164

165 *Comparison*

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

175

176 *Measures*

177 *Fundamental Movement Skills.*- FMS were examined using the Test of Gross Motor
178 Development-2 (TGMD-2) (Ulrich, 2000) protocol. The TGMD-2 was specifically designed and
179 validated to be used in the assessment of FMS among children aged 3-10 years (Ulrich, 2000). The
180 TGMD-2 measures the competency of 12 FMS, six locomotor (run, broad jump, leap, hop, gallop and
181 slide) and six object-control (overarm throw, stationary strike, kick, catch, underhand roll and
182 stationary dribble) skills. A senior member of the research team with significant experience in
183 administering the TGMD-2 was responsible for training all field testers, via *in-situ* observation, prior
184 to the start of data collection. Dependent on the facilities available, assessments took place in either
185 school halls or outside on school playgrounds, with children in small groups of between two and four,

186 led by two field testers. The first tester was responsible for providing a verbal description and single
187 demonstration of the skill required, while the second recorded each trial using a tripod mounted video
188 camera (Sanyo, Japan). In cases where a child did not understand the task they were being asked to
189 complete (e.g. they ran in the wrong direction), a further verbal description and demonstration of the
190 skill was given and they repeated the trial. Children performed each skill twice. All 12 skills were
191 completed in the same order, taking approximately 35-40 minutes per group.

192 Video recordings of children's FMS were converted to DVD, allowing video analysis to take
193 place at a later date. The Children's Activity and Movement in Preschool Study Motor Skills Protocol
194 (CMSP; (Williams et al., 2009) was chosen to assess FMS competency. The CMSP is a process-
195 oriented assessment, evaluating each skill based upon the demonstration of specific movement
196 components (Williams et al., 2009), such as "*arms move downward during landing*" for the jump (see
197 Tables 1 and 2 of (Williams et al., 2009). Whilst developed using an identical protocol to the TGMD-
198 2 (Ulrich, 2000), the CMSP provides improved assessment sensitivity due to its additional
199 performance criteria and alternative scoring methods (Williams et al., 2009). Furthermore, the CMSP
200 has demonstrated high reliability ($R=0.94$), inter-observer reliability ($R=0.94$) and concurrent validity
201 when compared to the TGMD-2 ($R=0.98$) (Williams et al., 2009).

202 All analyses were completed by a single trained assessor, following 30 hours of training from
203 a member of the research team experienced in undertaking video assessment of FMS. Interrater
204 reliability was established through the use of pre-coded DVDs of 10 children undertaking the TGMD-
205 2 protocol, with an 83.9% agreement found across the 12 skills (range 72.9-89.3%) for the individual
206 components of each skill. Intra-rater reliability was further established using pre-coded DVDs of a
207 further 10 children, with test-retest taking place one week apart. This resulted in a 91.9% agreement
208 for the 12 skills (range 89-96%). Despite there being no accepted minimum level of percentage
209 agreement, 80-85% agreement has previously been deemed as acceptable (van der Mars, 1989). If
210 unsure whether a child had met a performance criterion, the footage was reviewed by the assessor and
211 the experienced researcher, with a final decision on scoring agreed between the two.

212 Individual skill components (ranging from 3-8, dependent on the skill) were marked as absent
213 (0) or present (1) for both trials of each skill. If a skill component was successfully demonstrated

214 across both trials, then it was classed as present. Exceptions to this scoring system were present in
215 components 4 and 5 of the overhand throw and strike, where hip/trunk rotation was scored as
216 differentiated (2), block (1) or no rotation (0). Additionally the catch identifies a successful attempt as
217 either being “*caught cleanly with hands/fingers*” (2) or “*trapped against body/chest*” (1). In
218 accordance with the outcome measures of the CMSP (Williams et al., 2009), the number of individual
219 skill components classed as being present were summed to create a total score. Likewise, locomotor
220 and object-control scores were created by summing the number of present components within each
221 subscale.

222 *Anthropometry.*- Body mass (to the nearest 0.1 kg) and stature (to the nearest 0.1 cm) were
223 measured onsite using calibrated digital scales (Tanita WB100-MA, Tanita Europe, The Netherlands)
224 and a portable stadiometer (Leicester Height Measure, SECA, Birmingham, UK), respectively. Body
225 mass index (BMI, kg/m²) was calculated and converted to BMI z-scores (Cole, Bellizzi, Flegal, &
226 Dietz, 2000).

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

236 MLwiN v2.30 (Center for Multilevel Modelling, University of Bristol, UK) was used to
237 perform the main analysis, which comprised of multilevel linear regression analyses to examine
238 intervention effects on the dependent variables (total, locomotor and object-control scores). Multilevel
239 models effectively analyze the hierarchical nature of non-independent, nested data by taking into
240 account the dependency of observations (Goldstein, 1995). A 2-level data structure was used to
241 account for children being nested within their individual schools, whereby children were classed as

242 being the first level unit of analysis, with preschool the second. Analysis of the intervention effects
243 between baseline and post-test, and baseline and follow-up were conducted separately (Twisk, 2006).
244 Initially, a ‘crude’ analysis determined the intervention effect adjusting for baseline dependent
245 variable score only, whilst the second analysis ‘adjusted’ for sex, baseline decimal age and BMI z-
246 score (Barnett, Van Beurden, Morgan, Brooks, & Beard, 2010; Clark, 2005; Dylan P. Cliff et al.,
247 2012; Goodway et al., 2010; Jones, Okely, Caputi, & Cliff, 2010). Additionally, sex interactions were
248 explored in order to determine whether the intervention effects differed between boys and girls.
249 Regression coefficients in each model were assessed for significance using the Wald statistic with one
250 degree of freedom. Statistical significance was set at $p < 0.05$, and at $p < 0.10$ for the sex interaction
251 term.

252

253

Results

254

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

262

263

Insert Figure 1 Here

264

265 Baseline characteristics for the study participants (M age 4.64 yr., $SD = 0.58$; 53.1 % boys;
266 25.3% overweight/obese; 80.8% White British; 93.4% lived in a low socio-economic area) are shown
267 in Table 3. Competency levels were found to be low for all children at baseline, especially for object-
268 control skills, although children within the intervention group had significantly higher total ($t(160) =$
269 $-2.16, p = 0.03$) and object-control scores ($t(160) = -2.32, p = 0.03$) in comparison to children within

270 the control group. Boys within the intervention group had a significantly higher ($t(84) = -2.0, p =$
271 0.04) total FMS score than comparison boys at baseline, while intervention girls had a significantly
272 higher object-control score ($t(74) = -2.01, p = 0.04$) than comparison girls at baseline.

273

274 *Insert Table 3 Here*

275

276 *Intervention Effects*

277 No significant intervention effects on total, object-control or locomotor scores between
278 baseline and post-test or baseline and follow-up (see Table 4) were observed. However, small,
279 potentially practically meaningful, positive intervention effects were noted for total ($\beta = 1.45, 95\% \text{ CI}$
280 $-0.34 \text{ to } 3.24, p = 0.11$) and object-control ($\beta = 1.01, 95\% \text{ CI } -0.22 \text{ to } 2.24, p = 0.11$) scores in the
281 adjusted model between baseline and post-test, though any positive effects had diminished at follow-
282 up.

283

284 *Insert Table 4 Here*

285

286 *Sex Interaction Effects*

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

291

292 *Insert Table5 Here*

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294

295

Discussion

296

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

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

315 Other factors may have also contributed to the lack of substantial program effects on FMS,
316 including staff training components (Dwyer, Higgs, Hardy, & Baur, 2008), staff's prior experiences
317 (Derscheid, Umoren, Kim, Henry, & Zittel, 2010), the quality of delivery, and the program curriculum
318 (Bellows, Anderson, Gould, & Auld, 2008). The intervention included a 2-2-2 week experiential
319 learning training model that began with Active Play specialists delivering the program and ended with
320 the preschool staff independently delivering sessions. Within existing literature, there is no clear
321 consensus on the training required to effectively upskill preschool staff to improve children's FMS
322 competence. However, lessons could be learned from recent successful interventions that utilized
323 either a one-day workshop (Hardy, King, Kelly, Farrell, & Howlett, 2010; Piek et al., 2013) or a series
324 of brief workshops (Jones et al., 2011). Unlike the Active Play program, these occurred prior to

325 program implementation, and included a blend of practical and theoretical components – the latter
326 may have been useful in indoctrinating preschool educators’ into the Active Play program philosophy
327 and enhancing their knowledge and understanding of the program content. Whilst the present study
328 did not incorporate measurement of intervention fidelity, the absence of intervention effects at six-
329 month follow-up indicates that preschool staff may not have integrated the program within their
330 existing practice. The Active Play specialist practitioners did offer an on-demand support service for
331 preschool staff after the initial six-week program but more structured support, such as mentoring or
332 direct supervision, or opportunities for collaboration with peers (e.g. communities of practice), could
333 be considered by program planners.

334 It is also possible that the Active Play curriculum, which targeted physical activity, sedentary
335 behavior and 12 different FMS, was too broad in scope, particularly given the short duration of the
336 intervention. For example, the intervention reported by Jones et al. (2011) focused on only five skills
337 over a longer period of time and was able to bring about greater improvements in competency. It is
338 important to note that the Active Play program was, however, effective at increasing levels of
339 moderate-to-vigorous physical activity during sessions (O’Dwyer et al., 2013). The curriculum
340 activities and resource cards were designed to provide opportunities for children to explore and try
341 different FMS while engaging in moderate-to-vigorous physically active play. However, young
342 children may require more targeted and focused skill-development activities, with approaches
343 utilizing direct instruction, guided discovery or deliberate practice alongside the provision of positive
344 feedback (Donath et al., 2015; Draper, Achmat, Forbes, & Lambert, 2012; Gallahue & Donnelly,
345 2003; Goodway, Crowe, & Ward, 2003; Jones et al., 2011; Payne & Isaacs, 2002).

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

353 data. Such problems highlight common data collection difficulties when studying young children
354 within a preschool environment.

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

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557 **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

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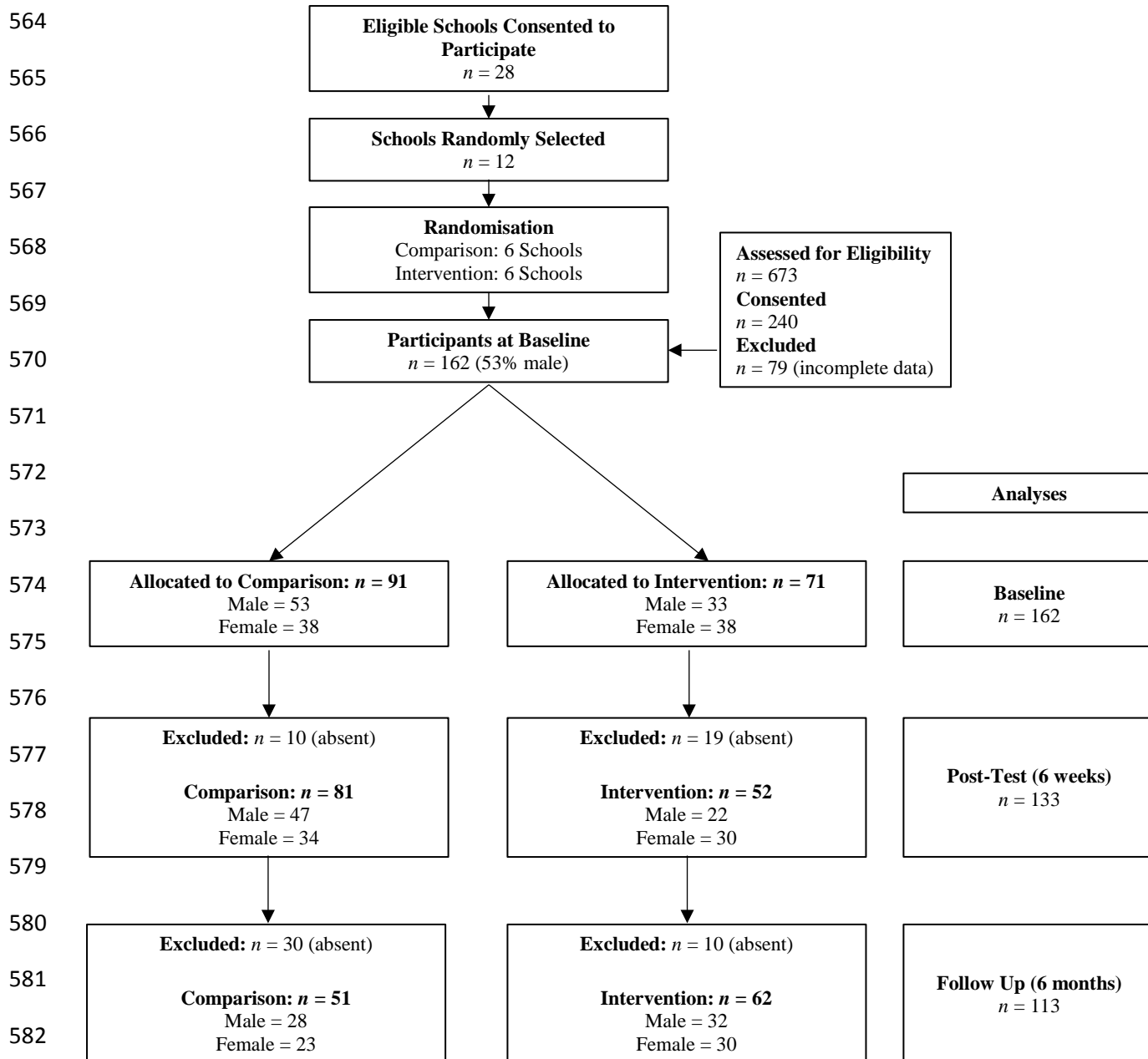
560 **Table 2.** Description of example Active Play cards.

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

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583 **Figure 1.** Flowchart of schools and participants through the study.

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586 **Table 3.** Baseline descriptive characteristics for intervention and comparison children (Mean \pm 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 \pm 0.6	4.5 \pm 0.6	4.6 \pm 0.6	4.7 \pm 0.7	4.7 \pm 0.5	4.7 \pm 0.6
Stature (cm)	108.7 \pm 6.2	105.9 \pm 5.7	107.6 \pm 6.1	107.4 \pm 5.5	107.6 \pm 4.8	107.8 \pm 5.1
Body Mass (kg)	19.9 \pm 3.7	18.7 \pm 3.1	19.4 \pm 3.5	19.3 \pm 2.9	19.1 \pm 2.5	19.2 \pm 2.7
BMI (kg/m ²)	16.7 \pm 1.7	16.7 \pm 1.8	16.7 \pm 1.8	16.7 \pm 1.6	16.5 \pm 1.4	16.6 \pm 1.5
IMD (%) [†]	90.0	91.7	90.7	96.8	97.1	97.0
Total FMS [‡]	26.2 \pm 7.1	25.8 \pm 6.6	26.1 \pm 6.9	29.4 \pm 7.1	27.5 \pm 5.9	28.4 \pm 6.5
Object- Control Score [‡]	11.1 \pm 4.2	9.2 \pm 3.1	10.3 \pm 3.9	12.8 \pm 4.2	10.7 \pm 3.4	11.7 \pm 3.9
Locomotor Score [‡]	15.2 \pm 3.9	16.7 \pm 4.4	15.8 \pm 4.2	16.6 \pm 4.3	16.8 \pm 3.6	16.7 \pm 3.9

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

590

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

Outcome Measure	Crude Model ^a		Adjusted Model ^b	
	β (95% CI)	<i>p</i>	β (95% CI)	<i>p</i>
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

593 *Note.*— β = beta coefficient. CI = confidence intervals. ^aAdjusted for baseline score. ^bFurther adjusted
 594 for sex, BMI-z score and age.

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

Outcome Measure	Intervention*gender ^a (crude model)		Boys ^b		Girls ^b	
	β (95% CI)	<i>p</i>	β (95% CI)	<i>p</i>	β (95% CI)	<i>p</i>
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

599 *Note.* - β = beta coefficient. CI = confidence intervals.^aAdjusted for baseline score. ^bFurther adjusted
 600 for BMI-z score and age. n/a = no significant interaction, follow up analyses not
 601 conducted.*Significant difference ($p < 0.1$).

602