Does Intervening in Childcare Settings Impact Fundamental Movement Skill Development?

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ABSTRACT

ADAMO, K. B., S. WILSON, A. L. J. HARVEY, K. P. GRATTAN, P.-J. NAYLOR, V. A. TEMPLE, and G. S. GOLDFIELD Does Intervening in Childcare Settings Impact Fundamental Movement Skill Development? Med. Sci. Sports Exerc., Vol. 48, No. 5, pp. 926–932, 2016. Purpose: Knowing that motor skills will not develop to their full potential without opportunities to practice in environments that are stimulating and supportive, we evaluated the effect of a physical activity (PA)-based intervention targeting childcare providers on fundamental movement skills (FMS) in preschoolers attending childcare centers. Methods: In this two-arm cluster-randomized controlled trial, six licensed childcare centers in Ottawa, Canada, were randomly allocated into one of two groups (three controls, n = 43; three interventions, n = 40). Participants were between the ages of 3 and 5 yr. Childcare providers in the experimental condition received two 3-h workshops and a training manual at program initiation aimed at increasing PA through active play and several in-center “booster” sessions throughout the 6-month intervention. Control childcare centers implemented their standard curriculum. FMS were measured at baseline and 6 months using the Test of Gross Motor Development-2. Results: Groups did not differ on sociodemographic variables. Compared with control, children in the intervention group demonstrated significantly greater improvement in their standardized gross motor quotient (score, 5.70; 95% confidence interval [95% CI], 0.74–10.67; P = 0.025 and gross motor quotient percentile, 13.33; 95% CI, 2.17–24.49; P = 0.020). Over the 6-month study period, the intervention group showed a significantly greater increase in locomotor skills score (1.20; 95% CI, 0.18–2.22; P = 0.022) than the control group. There was a significant decrease in the object control scores in the control group over the study period. Conclusions: A childcare provider-led PA-based intervention increased the FMS in preschoolers, driven by the change in locomotor skills. The childcare environment may represent a viable public health approach for promoting motor skill development to support future engagement in PA. Key Words: FUNDAMENTAL MOVEMENT SKILLS, EARLY CHILDHOOD EDUCATION, INTERVENTION, PHYSICAL ACTIVITY, CHILD CARE

Motor development, or the process by which a child acquires movement patterns and skills, has been shown to be positively associated with physical activity (PA) (11,16,26). It has been noted that children with low movement competence usually exhibit low PA levels (6,8) and tend to be vigorously active less often, play less on large playground equipment, and spend less time interacting socially with their peers (6). Early motor development and subsequent motor skill acquisition are critical factors in PA participation during later childhood and adolescence (4,16,22).

Fundamental movement skills (FMS) (e.g., catching, throwing, jumping, running) are essential building blocks for the acquisition of more refined and complicated skills that can be applied later in life, such as sport and recreational and physical activities (9,17,27). However, FMS will not develop to their full potential without opportunities to practice in environments that are stimulating and supportive (19,30). Butcher and Eaton (8) found that movement competence at a preschool age was already influencing their PA levels and their PA choices. In fact, findings from a subset of participants from the Children’s Activity and Movement in Preschool Study showed that children with better developed locomotor skills (i.e., running, jumping) spent more time in moderate-to-vigorous PA and less time sedentary than children with poorer locomotor performance (35). As such, researchers and health professionals concerned about pediatric growth and development aim to identify favorable environments for intervention, focusing on health behaviors in young children to optimize health and
prevent chronic diseases related to inactivity. The childcare environment, where up to 80% of today’s preschoolers spend most of their waking hours (7,10,28), has been identified as a worthwhile target offering great potential for PA-based interventions that can impact the development of FMS and proficiency.

Knowing that the preschool years represent a critical developmental period, that FMS competence is a key determinant of PA behavior over time (29), and that the environments in which young children spend their time greatly influence their behavior, this study evaluated the effect of the Preschoolers Activity Trial PA-based intervention targeting childcare providers on FMS in preschoolers attending childcare centers. It was hypothesized that the FMS would improve more in the intervention group over the study period as compared with the control group.

METHODS

Study Design

This two-arm, parallel group cluster-randomized controlled trial took place in Ottawa, Canada, and evaluated the efficacy of a childcare provider-led intervention to impact FMS (see Fig. 1, CONSORT diagram). This trial was registered with ClinicalTrials.gov (Identifier: NCT02293278).

Procedures

The study was approved by the Research Ethics Board at the Children’s Hospital of Eastern Ontario. A presentation was made at a local early childhood educator workshop; childcare centers interested in learning more about the study were asked to provide their contact information to the study staff. Upon expression of interest, follow-up with eligible childcare centers in Ottawa was conducted by research coordinators by providing them with detailed study information and inviting them to participate in the study. Childcare centers were eligible if they enrolled more than 10 children on a full-time basis between the ages of 3 and 5 yr at the time of consent. Childcare centers whose director agreed to allow the study personnel to visit their facilities for planned assessments, provided commitment to modify their curriculum and support their staff in facilitating the required changes accordingly (in consideration of possible randomization), and had consent from the childcare providers themselves, were eligible for participation and randomization. Considering potential seasonal effects, the study took place using two cohorts, with equal numbers of intervention and control daycare centers in each arm. Cohort 1 began in winter (February) of 2011 and 6-month outcomes were assessed in summer (August) of 2011. The second cohort began in the fall (October) of 2011 and 6-month assessments were performed in the spring (May) of 2012. PA outcomes based on accelerometry, the primary outcomes/objectives of the current study, are reported elsewhere (Goldfield et al., 2015 personal communication).

Six childcare centers (clusters) that met the aforementioned inclusion criteria were selected and randomly assigned, using a computer-generated random number sequence by a statistician unaffiliated with this trial, to one of two groups: i) childcare provider-led intervention (n = 3) or the control group offering regular childcare curriculum (n = 3). Although the whole childcare environment was subjected to the intervention, only children whose parents signed the informed consent were assessed. The sample consisted of 83 children (40 intervention, 43 controls) age 3 to 5 yr attending licensed childcares in Ottawa, Canada. Although the research staff was not blinded to group assignment during assessment, outcome measures, such as PA (accelerometry) and body composition (height, weight, BMI), were measured objectively, thus reducing any potential bias. For gross motor development outcomes (Test of Gross Motor Development-2 [TGMD-2]), two research staff (graduates of kinesiology/human kinetics) were trained by an experienced TGMD-2 examiner on how to deliver and subsequently score a practice sample of preschooler-age children before study assessments. For the present study’s gross motor assessments, each score was determined based on observations made by the two research staff. A consensus was reached between the two examiners based on discussion, and the agreed upon score was recorded on the assessment sheets. The completed assessment sheets were scored using the TGMD-2 scoring protocol (33). As it is recommended that two trained individuals score a set of tests independently (3), one research staff initially scored all of the assessments followed by another research staff member independently. Few discrepancies were noted, which suggests that inter-rater reliability was adequate.

FIGURE 1—CONSORT flow diagram.
Intervention

The Preschoolers Activity Trial intervention consisted of the delivery of two 3-h training workshops to childcare providers in the evenings in group format, outside of the child care setting. These were led by an early learning PA specialist, referred to as the master trainer. The intent of the first workshop was to set the stage regarding why such an intervention was necessary within the childcare system, what we sought to achieve and to facilitate a greater understanding of the role and benefits of both structured and unstructured plays. An overview of the design, assessment methodologies, and expectations were also provided in further detail. The intent of the second workshop was to disseminate the literature-based PA resource manual, Healthy Opportunities for Preschoolers (31), and to also teach the providers how to foster a childcare environment that provides ample opportunities to be physically active throughout the day (e.g., provide daily outdoor PA time whenever possible, actively participate with the children, move portable furniture/equipment to facilitate more PA within and outside of the classroom, and so on). The HOP manual (http://www.haloresearch.ca/uploads/HOP-manual.pdf) provided instruction and examples on how providers could facilitate daily PA that targeted locomotor skills, FMS, and active play. The childcare providers also received a set of resource tools including a PA kit that included some basic equipment, such as skipping ropes, balls, bean bags, and so on, and the HOP training manual which clearly outlined how the childcare providers could facilitate structured and unstructured physical activities, using large muscle groups, with preschool-age children that targeted FMS and active play. In addition to PA guidelines, these intervention binders included the Canadian Society for Exercise Physiology Sedentary Behavior Guidelines (32) which indicate that children should not be sedentary for more than 60 min at a time. These binders included a recommended weekly activity program and associated log sheets as well as an inclement weather plan. Biweekly adjunctive “booster sessions” were implemented by the master trainer during standard childcare hours to assist the childcare providers with program implementation, motivation, and problem solving, as well as modeling how to facilitate PA and FMS with the children using the resource kit provided. The booster sessions lasted between 60 and 90 min. The childcare providers were encouraged to incorporate more PA throughout the child’s day, independent of whether they were inside versus outside or whether the weather was favorable or not.

Control

Participating childcare centers that were randomized to the wait list control continued to provide their standard childcare curriculum during the study period. All control centers received the staff training and study resources after final data collection was completed, but no evaluation of the effects was conducted.

Assessments

Data were collected by a trained project staff and the baseline measurement took place before the workshops were delivered to the providers. Childcare centers engaged in the study for a 6-month period, with final postmeasurement assessments taking place 6 months postworkshop delivery.

Fundamental movement skills. The TGMD-2 was used to evaluate the effects of the intervention on children’s FMS (33). The TGMD-2 is a validated, standardized norm-referenced measure of common FMS in children ages 3 to 11 yr (14). The TGMD-2 evaluates 12 skills divided into two subtests: 1) locomotor (run, hop, gallop, leap, horizontal jump, and slide) and 2) object control (ball skills, such as striking a stationary ball, stationary dribble, catch, kick, overhead throw, and underhand roll). The gross motor quotient (GMQ), or the composite of these two subtests, is the most reliable score and is the recommended value to be used when interpreting the TGMD-2 scores (33). In addition to standardized scores, we are also reporting outcomes in percentiles because these values are most meaningful for interpretation. This test was conducted on participating children at baseline and at 6 months postintervention.

Anthropometrics. Height was measured using a portable stadiometer (Seca GmBH & Co Kg, Hamburg, Germany). Body weight was assessed using a digital scale (ProFit Precision Personal Health Scale, UC-321; A&D Medical, San Jose, California). Body mass index was calculated based on weight (kg) divided by height (m²).

Physical activity. Total PA was measured using omnidirectional Actical® accelerometers (Mini Mitter Co., Inc., Bend, OR). These activity monitors, which measure the frequency, duration, and intensity of motion, were worn for a 7-d period at each measurement time point (baseline and 6 months postworkshop). Data were collected in 15-s epochs, a time frame more representative of the sporadic nature of activity and play in the preschool years and, in harmony with the Canadian Health Measures Survey approach (12), time spent at various intensities of movement (e.g., sedentary, light, moderate, vigorous) were derived using Adolph et al.’s (2) cut points for preschool-age children’s PA intensity. Data for the current study analyzed activity data accrued in standard childcare hours (8:30 am to 4:30 pm, Monday to Friday) to represent the time frame in which most children were at the childcare center. Consistent with previous research targeting PA measurement in the childcare environment (5,15), children with at least 4 h of valid wear time during childcare hours on 2 or more days per week were included in a parallel analyses specifically examining PA, sedentary behavior, and anthropometrics (Goldfield et al. 2015, in review). All activity values were adjusted for total wear time to control for any variation between groups.

Analyses

Baseline characteristics were assessed using an independent-samples t-test, chi-squared tests or Mann–Whitney U test.
TABLE 1. Descriptive characteristics of the sample, mean ± SD unless otherwise noted.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control, N = 43 (M, 23; F, 20)</th>
<th>Intervention, N = 40 (M, 16; F, 22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>3.4 (0.4)</td>
<td>3.4 (0.3)</td>
</tr>
<tr>
<td>3–3.9</td>
<td>39</td>
<td>36</td>
</tr>
<tr>
<td>4–4.9</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>98.6 (4.6)</td>
<td>98.6 (4.9)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>15.7 (2.0)</td>
<td>15.9 (2.0)</td>
</tr>
<tr>
<td>Body mass index (kg m⁻²)</td>
<td>16.1 (1.1)</td>
<td>16.5 (1.0)</td>
</tr>
<tr>
<td>Household income, N (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than US $100,000</td>
<td>7 (16.3)</td>
<td>11 (27.5)</td>
</tr>
<tr>
<td>Less than US $20,000</td>
<td>0 (0)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>US $20,000–29,999</td>
<td>0 (0)</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>US $30,000–39,999</td>
<td>0 (0)</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>US $40,000–49,000</td>
<td>0 (0)</td>
<td>2 (5.0)</td>
</tr>
<tr>
<td>US $50,000–99,999</td>
<td>7 (16.3)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>Greater than US $100,000</td>
<td>25 (58.1)</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>Refuse to answer/no response</td>
<td>11 (25.6)</td>
<td>12 (30.0)</td>
</tr>
</tbody>
</table>

The analyses were conducted using an intention-to-treat basis that included all participants with TGMD-2 assessments (as outlined in Fig. 1) within the randomly allocated intervention and control childcare centers. To assess the effects of the intervention on changes in outcome measures, we used linear mixed-effects modeling for repeated measures over time using the GMQ, locomotor skills (composite and individual skill scores), and object control skills (composite and individual skill scores) as dependent variables, and effects for time (baseline vs 6 months), group (intervention vs control), and group–time interaction as fixed independent variables. The childcare cluster was included as a random effect using the autoregressive covariance matrix and the individual participants as part of each childcare cluster were assessed as a repeated effect using the autoregressive covariance matrix. Individual locomotor and object control tasks were also assessed using the mixed models with four of the skills (hop, slide, dribble, and throw) transformed before entry into the model because of low scores for the majority of children in these areas. Individual locomotor and object control tasks were also adjusted for age by using baseline age (in years) as a covariate in the model. Within the mixed models, 95% confidence interval (95% CI) and P values were calculated for within and between group differences over time. Standardized statistical software (SPSS, version 18) was used for outcome analyses, and statistical significance was defined as an alpha of less than 0.05.

RESULTS

Table 1 displays child and parental sociodemographic and anthropometric characteristics at baseline. There were no differences between groups on any of these variables.

The FMS outcomes, expressed as standardized scores and percentiles, are provided in Table 2. As shown in Figure 2, the intervention group demonstrated significantly greater change in their GMQ (score, 5.70; 95% CI, 0.74–10.67; P = 0.025 and percentile, 13.33; 95% CI, 2.17–24.49; P = 0.020) compared with controls with an effect size of 0.59 and 0.61 for score and percentile, respectively.

Examining the subset scores, the difference between groups in locomotor skills was also statistically significant (1.20; 95% CI, 0.18–2.22; P = 0.022) with an effect size of 0.61. Both intervention and control groups locomotor skills percentile increased from baseline to 6 months, but only the intervention group’s improvement was significant (15.03 vs 2.44; effect size, 0.62; see Table 2). Figure 3A displays the pre–post changes for each of the individual locomotor skills. Both the intervention and control groups showed significant improvement in the gallop, hop, and slide. The intervention group also improved their horizontal
jump score significantly more than control \((P = 0.001)\). Other than for leap, the effect sizes were consistently greater in the intervention compared with the control group for the change in each of these FMS (data not shown).

From baseline to 6 months, the control group experienced a significant decline in object control skills \((-0.68; 95\% \text{ CI}, -1.33 \text{ to } -0.02; P = 0.043)\), whereas there was no change in the intervention group. The mean difference in object control skills change score between groups was not significant \((P = 0.252)\). Figure 3B illustrates the pre–post measurements in individual object control skills with a significant within group difference being an improvement in the ball rolling scores for children in the intervention group, with the between group change nearing significance \((P = 0.05)\). The control group also significantly improved their dribbling skills.

With regard to actual PA engagement, the intervention group also demonstrated significantly greater changes in total PA (mean difference, 20.8 min \(^{-1}\); 95% CI, 7.1–34.6; \(P = 0.004\)) but not MVPA (mean difference, 4.3 min \(^{-1}\); 95% CI, −2.5 to 11.1; \(P = 0.210\)). A more detailed PA behavior analysis can be found elsewhere (Goldfield et al. 2015, in review).

**DISCUSSION**

FMS competence is an important contributor to a child’s PA and fitness levels and has been shown to positively impact leisure time pursuits, organized sport, and overall health \((9,17,27)\). This study demonstrated that a brief, childcare center-based, provider-led, PA intervention improved FMS over the traditional preschooler curriculum. Our data also indicated that the change in locomotor, rather than object control skills, was the driver for the overall improvement of FMS skills seen in the intervention group with medium to large absolute (between group) effect sizes for running \((0.46)\), hopping \((0.31)\), and jumping \((0.85)\). The only object control skill improvement that was different between groups was the underhand roll component with an absolute effect size of 0.52.

It is recognized that the success of interventions hinges on several factors including the intensity, the time over which it is delivered, the environment (e.g., center-based space, equipment, policies), the engagement of the caregivers and center staff, the children involved, and the strength of the assessments. Given our 6-month PA intervention, expected to be integrated as part of the daily curriculum, placed more emphasis on large muscle activities and games aiming to increase overall PA levels, we were not surprised that participating preschool children showed greater improvement in locomotor skills. Many studies that have examined the impact of an intervention on FMS have not reported on locomotor and object control skills independently \((24)\). Indeed, results from a longitudinal examination of Australian children who had been part of a preschooler movement skill intervention \((36)\) show that object control skills require more targeted approaches over locomotor skills as children consistently score lower in this subtest and that even children who were behind in locomotor skills initially gain these skills overtime and “catch up.” Our study results, similar to those of Wang \((34)\) whose preschooler creative movement intervention found improvements in locomotor skills and
not object control, support the contention that incorporating specific activities or play-based learning that emphasizes object control skills is likely necessary to see measurable improvements.

Our mean percentile for GMQ at baseline was 45, indicating that Canadian preschool-age children attending licensed childcare centers have average FMS (i.e., 25th to 75th percentile). Albeit not significantly different, our intervention group started the study with lower mean GMQ percentiles (42 vs 48) and more of these parents reported being in the lower household income bracket (6 with household income < 40,000 vs 0 in control). This is in keeping with data presented by Mitchell et al. (21), who, in their examination of FMS in 5- to 7-yr-old children, identified that children in schools from communities with lower socioeconomic status had lower baseline test scores. Despite the initial disparity, the Mitchell study (21) also indicated that an intervention that provided classroom teachers with tools for improving motor skills improved FMS competency in children and that improvement was not hindered in those from lower socioeconomic status environments.

In the current study, unlike the intervention group, who saw a significant improvement in their GMQ (score + 4.18 or percentile + 9.64), there was no change in the control group’s GMQ, which dipped below the 45th percentile at the end of 6 months. We would expect to see age-related improvements in overall FMS; however, we did not see this in the control group and believe the significant difference between groups to be largely related to the curriculum change in the intervention group which resulted in corresponding increase in objectively measured daily PA (from 155.6 min d⁻¹ at baseline to 174.4 min d⁻¹ at 6 months P = 0.001; Goldfield et al. 2015, in review, compared with the control group whose total PA in the childcare setting did not change (158.4 min d⁻¹ to 156.4 min d⁻¹)). The improvements in FMS observed by children in the intervention group were primarily driven by increases in locomotor skills (i.e., jumping), which are clinically meaningful given these gross motor skills are critical to increasing overall PA.

**Strengths and limitations.** This was the first Canadian randomized controlled trial to examine the effects of a PA-based intervention on FMS in preschoolers attending licensed childcare centers. The study assessments performed in this trial include standardized objectively measured anthropometrics, and PA and used a well-validated measure of FMS in this population (TGDM-2) by well-trained study staff. We examined the composite GMQ, as well as the locomotor and object control subtests, including the individual skills for each subtest. Generalizability of our study is limited due to the use of a relatively small convenience sample and thus observations need to be confirmed with a larger sample size to better evaluate treatment effects. Our sample size also limited our ability to examine our data by sex but others have provided evidence indicating that motor skills may develop at different rates and degrees and that sex-specific interventions may be required that target certain skills (18,36). Thus, future work should examine boys and girls separately with regard to the impact of preschooler interventions on motor skill development. Although our intervention effect obtained at 6 months is comparable to or greater than most other studies, future research using longer “follow-up” assessments are needed to determine whether the significant improvements observed in preschoolers’ FMS skills with brief, behavioral intervention provided to childcare providers can be maintained over time.

A recent systematic review and meta-analyses performed by Logan et al. (20) has shown that PA-based intervention to improve FMS in children is an effective strategy to improve competence. Importantly, the nonsignificant effect in the control groups included in this systematic review, consistent with our current Canadian study’s findings, support the contention that motor skill competence does not develop naturally, but rather children must be educated in these skills which then need to be practiced and reinforced. By focusing on the childcare environment, our findings have important public health implications for health promotion and disease prevention given the important role that motor skills play in sustaining PA throughout development (4,16,22). Although most studies targeting preschoolers have examined researcher- or “specialist”-led PA interventions, as indicated in Riethmuller’s systematic review (25), larger RCTs similar to our current study are underway examining childcare provider-led PA interventions in the childcare environment (1,14,23). In addition, as primary role models, parents are also in a position to greatly influence their child’s PA and FMS development in ways that might be better tailored to their child’s specific needs and with a degree of continuity. Given that children will undergo several “school-based” transitions over their lifetime, future research is needed to determine if targeting parents in PA interventions can enhance and better sustain the effects on FMS development above and beyond those obtained by targeting childcare providers alone.

**CONCLUSIONS**

The preschool years and the environments in which young children spend their time are vital to the development of FMS. Results from this study illustrate that investing in learning environments via brief behavioral intervention with childcare providers targeting increased PA can beneficially impact FMS development in preschoolers skills, which once learned, tend to endure and may contribute to healthy active living trajectories and associated health benefits throughout life.

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The authors have no conflicts of interest to declare.

The authors’ contributions were as follows: K. B. A. and G. S. G. obtained funding, significant manuscript writers, concept and design, data analysis, and data interpretation. S. W. is a significant manuscript reviewer, provided statistical expertise, participated in data analysis, and interpretation; K. G. & A. L. J. H. were primarily responsible for data acquisition and are significant manuscript reviewers. P. J. N. and V. A. T. were significant manuscript reviewers and participated in study concept and design and data interpretation. All authors provided feedback on the draft of this article and read and approved the final article.

Trial Registration: ClinicalTrials.gov Identifier: NCT02293278.