Pediatric Exercise Science, 2011, 23, 600-615

Promoting Fundamental Movement Skill Development and Physical Activity in Early Childhood Settings: A Cluster Randomized Controlled Trial

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The aim of this study was to assess the feasibility, acceptability and potential efficacy of a physical activity program for preschool children. A 20-week, 2-arm parallel cluster randomized controlled pilot trial was conducted. The intervention comprised structured activities for children and professional development for staff. The control group participated in usual care activities, which included designated inside and outside playtime. Primary outcomes were movement skill development and objectively measured physical activity. At follow-up, compared with children in the control group, children in the intervention group showed greater improvements in movement skill proficiency, with this improvement statically significant for overall movement skill development (adjust diff. = 2.08, 95% CI 0.76, 3.40; Cohen's d = 0.47) and significantly greater increases in objectively measured physical activity (counts per minute) during the preschool day (adjust diff. = 110.5, 95% CI 33.6, 187.3; Cohen's d = 0.46). This study demonstrates that a physical activity program implemented by staff within a preschool setting is feasible, acceptable and potentially efficacious.

Australia and New Zealand Clinical Trials Registration Number: 082604

The early years (broadly speaking 3–5 years-old) have been identified as a critical time for the development of healthy behaviors, such as physical activity (39). A rationale for promoting physical activity is that it provides the milieu for

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movement skills to develop, with movement being the substrate for physical activity during these early years (22). Unfortunately, many young children are not engaging in sufficient physical activity (39) nor showing sufficient development in their movement skills (14,24).

Early childhood settings have a central role in the promotion of physical activity and movement skill development as the majority of preschool-aged children attend preschool (38,26) and settings generally have the resources to implement physical activity or movement skill programs (39). Furthermore, movement skill development is a core element of preschool curricula (6). As such, interventions to improve movement skills and promote physical activity in young children have been a priority (14). Riethmuller et al. (28) recently reviewed physical activity programs for preschool children, specifically those focusing on movement skills. Of the 10 published studies reviewed, 50% were successful in improving movement skill proficiency, however, several significant limitations were identified. First, the overall methodological quality of the studies was poor with few aligned to either the CONSORT or TREND statements (1,7); Second, most studies were implemented by research staff, limiting the sustainability of the programs in these settings; and third, the majority were less than 11 weeks in duration. Longer interventions, certainly among older children, have been suggested to be more effective (41).

To address these limitations, a movement skill development program, aimed at promoting physical activity in early childhood settings, was designed, implemented, and evaluated. This paper reports on the feasibility, acceptability and potentially efficacy of this program. We hypothesized that children participating in the intervention program, compared with children in the control group, would show greater improvements in movement skill development and greater increases in physical activity during preschool hours.

Methodology

Design and Participants

This was a 20-week 2-arm parallel cluster pilot randomized controlled trial comparing a movement skill development physical activity program (*Jump Start*) with usual care (control group). Two childcare centers were purposively selected by a local governing early childhood corporation (Illawarra Children's Service, March 2008). The centers were chosen based on similarities in size, resources, equipment and the socioeconomic regions from which they drew their children (parental yearly income, education level and language spoken at home). Centres (comprising one class each) were randomized using a computer generated random number producing algorithm and the bias coin method, following baseline measurements. Children aged between 3 and 5 years were eligible to participate if they were enrolled on a permanent basis either on Monday, Tuesday and/or Friday (i.e., the days the intervention was implemented). There were no exclusion criteria. Parents or guardians provided informed consent and the study was approved by the University of Wollongong Human Ethics Research Committee.

Treatment Intervention (*Jump Start*)

The treatment intervention was designed in response to formative research conducted within early childhood settings (29) and a proof-of-concept feasibility study implemented in a separate childcare setting during 2007.

Jump Start is a movement skill development physical activity program, implemented primarily by setting staff. It comprises two components: professional development for setting staff and structured lessons and unstructured activities for children. The professional development involves 4 × 30min workshops and includes both theory and practical components. Each 20-min structured lesson focuses on one fundamental movement skill: children are encouraged to explore the different movement concepts related to the skill (e.g., running fast or slow) and each component of the skill. Each skill comprises a number of components, for example, the skill of running has four components (9). (A description of the program is provided in Table 1.) Lastly, children practice the skill, through a series of fun activities and games. Structured lessons were implemented three times a week for 20 weeks (Table 1). Unstructured activities are facilitated in the afternoons of the structured lessons with the aim of offering an additional opportunity for the children to practice the skills learnt in the structured lessons. Specific equipment is provided during the unstructured activities to encourage participation (for example, if the skill of catch was taught in the morning, a greater number of balls would be available to play with in the afternoon and staff specifically facilitated catching games).

The Control Group

The control group continued with their usual program, which included designated time outside for free play.

Measures

Measures were taken at baseline (before randomization; April 2008) and at follow-up (late October 2008) on both the intervention and control participants. In addition, physical activity was measured in the intervention group in the final two weeks of the intervention (mid October 2008). This was to ascertain if physical activity levels were different during the implementation period, where structured lessons were compulsory, compared with follow-up (when the formal intervention period had ended). Trained independent assessors, blind to group allocation, conducted all measures. The primary outcomes were movement development and objectively measured physical activity, with body mass index (BMI) a secondary outcome.

Primary Outcomes

Movement skill development was assessed using the Test of Gross Motor Development (second edition), which has established validity for use with young children (34). Following a visual demonstration by a trained assessor, children performed each skill twice. Children's skill performances were video recorded and later analyzed by a trained assessor to allow greater measurement scrutiny. Each skill was scored ("1" indicated the individual components of each skill were present and "0" indicated they were not). Scores for each child were calculated by totalling the

Table 1 Description of *Jump Start* Movement Skill Development Program and Facilitators

Week	Focus Skill and Lesson	Focus Skill Components	Facilitator of structured lessons	Facilitator of unstructured lessons
1	Run (L1*)	Eyes forward, arms swing in opposition to legs	Researcher**	Researcher
2	Run (L2)	Eyes forward, arms swing in opposition to legs, land on the ball of foot	Researcher	Setting Staff
3	Catch (L1)	Eyes on object	Researcher	Researcher
4	Catch (L2)	Eyes on object, reach hands out and bring object in	Setting Staff	Setting Staff
5	Jump (L1)	Eyes forward, bend knees on landing, take off and land on two feet	Setting Staff	Researcher
6	Jump (L2)	Eyes forward, bend knees on landing, take off and land on two feet, swing arms	Setting Staff	Setting Staff
7	Kick (L1)	Eyes on object	Setting Staff	Researcher
8	Kick (L2)	Eyes on object, non kicking foot next to ball	Setting Staff	Setting Staff
9	Hop (L1)	Eyes forward, one foot up (nonsupport foot behind body)	Researcher	Setting Staff
10	Hop (L2)	Eyes forward, one foot up (nonsupport foot behind body)	Setting Staff	Setting Staff
11	Run (L1)	Eyes forward, arms swing in opposition to legs	Setting Staff	Setting Staff
12	Run (L2)	Eyes forward, arms swing in opposition to legs, land on the ball of foot	Setting Staff	Setting Staff
13	Catch (L1)	Eyes on object	Setting Staff	Setting Staff
14	Catch (L2)	Eyes on object, reach hands out and bring object in	Setting Staff	Setting Staff
15	Jump (L1)	Eyes forward, bend knees on landing, take off and land on two feet	Setting Staff	Setting Staff
16	Jump (L2)	Eyes forward, bend knees on landing, take off and land on two feet, swing arms	Setting Staff	Setting Staff
17	Kick (L1)	Eyes on object	Setting Staff	Setting Staff
18	Kick (L2)	Eyes on object, non kicking foot next to ball	Setting Staff	Setting Staff
19	Hop (L1)	Eyes forward, one foot up (nonsupport foot behind body)	Setting Staff	Setting Staff
20	Hop (L2)	Eyes forward, one foot up (nonsupport foot behind body)	Setting Staff	Setting Staff

* L = Lesson; Two different lessons were implemented for each movement skill. Each lesson focused on different components of the skills and were delivered three times per week. ** The researcher facilitated some lessons as part of the ongoing professional development for staff.

correctly performed components for two trials for each skill. Each skill comprises 3–5 components, thus if a skill comprises three components the score range is 0–6, 4 components the score range is 0–8 and 5 components, the score range is 0–10. To give a total score, individual scores were standardized and summed as per the assessor manual. The maximum total score was 40.

Physical activity was measured objectively using MTI 7164 Actigraph accelerometers (MTI Health Services, Fort Walton Beach, Florida, USA). Each child wore an accelerometer on their right hip for two consecutive days while attending childcare (i.e., accelerometers were fitted on intervention days when children arrived at the center and removed before they went home). Data were collected in 15-s epochs. Average counts per minute and percentage of time spent in sedentary and in light (LPA; <3 METs), moderate (MPA; 3–5.9 METs), vigorous (VPA; (³6 METs) and moderate-to-vigorous (MVPA) physical activity were calculated using age-specific child-validated equations developed by Sirard and colleagues (31).

Secondary Outcome

Height and weight were measured using standardized procedures and used to calculate BMI (kg/m^2).

Process Measures

Process measures were included to assess intervention feasibility, including fidelity, dose, reach and acceptability of the intervention components. These included evaluations of the structured lessons, using a standardized checklist, and individual semistructured interviews with setting staff (n = 7, 100% female) at baseline and follow-up.

Statistical Analyses

Data were analyzed with SPSS version 16 using intention-to-treat principles. The intervention and control groups were compared using analysis of covariance, with the follow-up measure as the dependent variable, group as the independent variable, and the baseline measure as the covariate (37). A post hoc analysis was performed to adjust the significance tests for the clustered nature of the data. The adjustment was conducted using the approach of Hedges (15), which involves a correction to the t-test using a multiplicative factor. The study data for the variables of interest were converted to a change score (follow-up—baseline), which were then compared using an independent samples t test for the difference between treatment and control groups. The main analysis was presented as an ANCOVA; however, the computationally simpler approach using a t test has been used in the adjustment and relies on the relationship between the t and F statistic when it is a two group comparison, ($t^2 = F$). In the absence of a value of an intraclass correlation from the sample studied, a range of external estimates were employed from the literature (35), in this case the values (intraclass correlations of 0.01 and 0.05) were obtained from the work of Murray and colleagues (23).

As a pilot study, this RCT was not adequately powered to detect statistically significant differences between groups. As such, standardized effect sizes were calculated to demonstrate effects and trends, and are the focus of the results and

discussion. Effect sizes of approximately 0.2, 0.5 and 0.8 are generally considered small, medium and large effects, respectively (3).

Results

The mean age of participants was 4.13 years, with 71% (69/97) classified as non-overweight, 22% (21/97) as overweight, and 7% (7/97) as obese at baseline (4). The flow of participants through the study is shown in Figure 1.

Based on the results from our proof-of-concept feasibility trial, we suggested a priori that the study would be feasible if: 60 participants were recruited; 80% of

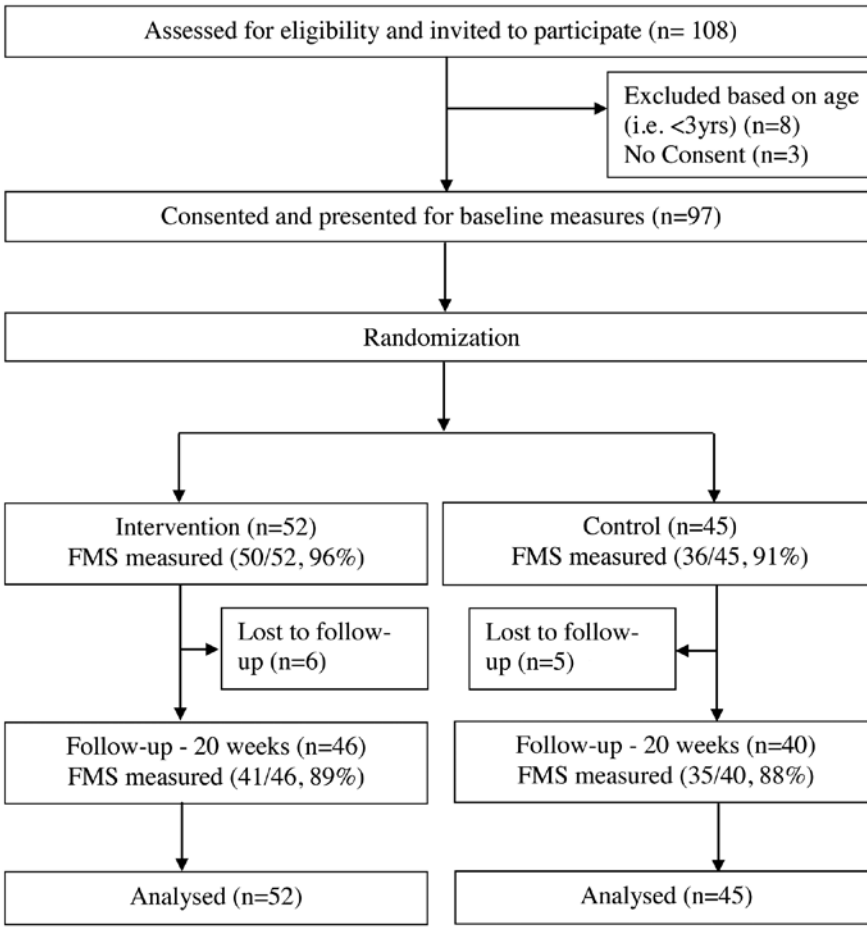

Figure 1 — Flow of individual participants through study (Adapted from Campbell et al., [2]). Reasons for no consent—child welfare cases ($n = 2$) and not wanting to be involved in a research project ($n = 1$). Reasons why not follow-up—6 children left the intervention center and 5 children left the control center.

participants were retained; and 100% of data would be collected at baseline and follow-up, except for objectively measured physical activity (90% of data could be collected, to account for equipment malfunctions). Ninety-seven participants were recruited and 89% were retained. Movement skill data were collected for 94% of participants at baseline and 88% at follow-up. Objectively measured physical activity data were collected for 96% of participants at baseline and 97% at follow-up. Height and weight data were collected on 95% of participants at baseline and 97% at follow-up.

We postulated, again based on our proof-of-concept feasibility trial, that the program would be acceptable if: 100% of the professional development content and structured lessons were delivered; staff reported that 90% of the program content was appropriate; and staff reported high satisfaction with the program. All professional development content and structured lessons were delivered. For all structured lessons, staff strongly agreed that the length of the lesson (mean of means 4.74 out of 5), the activities provided (4.75 out of 5), the number of activities (4.86 out of 5), the time needed to set up the equipment and the equipment needed for the lessons (4.89 and 4.91 out of 5, respectively) were highly appropriate.

Overall, staff reported high satisfaction with the program and suggested that children engaged with the activities and were motivated to participate in the program. Several staff commented that they could clearly see a difference in the movement skill development of the children. In addition staff identified several strengths of the structured lessons, including the variety in the activities. Staff also suggested that the "hands-on nature" of the professional development workshops encouraged them to work collaboratively and facilitated acquisition of new knowledge.

> [Delivering the Professional Development] in the workshops worked really well… it was good that everyone was at once doing it together…we all knew that when we were doing the lessons we could jog each other memories if we forgot [something]…

The potential efficacy results are summarized in Tables 2 and 3. For movement skill development, greater improvements were reported for each individual skill in the intervention group compared with the control group. A medium-to-large effect size was reported for the jump (d = 0.75) and statistically significant differences between intervention and control groups were reported for jump and for the sum of the five skills assessed (referred to as overall movement skill development in Table 2; $p = .00$). The intervention group, compared with the control group, reported significantly greater increases in objectively measured physical activity (counts per minute) in the final two weeks of the intervention ($p = .01$, adjust diff. = 110.48, 95% CI 33.62, 187.33; Cohen's d = 0.40; Table 3). In addition, during the final two weeks of the program, the intervention group spent less time being sedentary and more time in light- and moderate-to-vigorous intensity physical activity. (These analyses involved posttest intervention (follow-up) measures for the control group, which would be assumed to be the same two weeks earlier when during intervention measures were being taken on intervention group). However, at follow-up, differences in physical activity between the intervention and control groups were not maintained (Table 3).

Table 2 Changes in Movement Skill Development Proficiency and Body Mass Index for Intervention and Control Groups

	Baseline		Follow-up		6-month differences			
	Intervention Mean (*SD*) *N* = 52	Control Mean (*SD*) *N* = 45	Intervention Mean (*SD*) *N* = 52	Control Mean (*SD*) *N* = 45	Adjusted I-C Difference (95% CI)	P value	P value Adjusted for ICC (0.01–0.05)*	Effect size (Cohen's d) **
Movement skill Development								
Run (range 0–8)	5.55 (1.87)	5.93 (1.45)	6.22 (1.74)	6.40 (1.38)	0.02 (-.052, 0.57)	0.94	0.60–0.73	0.01
Hop (range 0–10)	2.53 (2.13)	2.09 (2.17)	3.88 (2.66)	2.88 (2.31)	0.65 (-0.11, 1.42)	0.09	0.24–0.44	0.26
Jump (range 0–8)	2.61 (1.71)	2.74 (1.50)	4.06 (2.21)	2.72 (1.50)	1.41 (0.69, 2.13)	0.00	0.03–0.05	0.75
Catch (range 0–6)	2.29 (1.19)	2.47 (1.42)	2.92 (1.20)	2.84 (1.36)	0.16 (-0.32,0.63)	0.52	0.52–0.63	0.12
Kick (range 0–8)	3.65 (1.95)	3.67 (1.61)	4.73 (1.83)	4.33 (1.90)	0.42 (-0.18, 1.01)	0.17	0.28–.048	0.23
Total Score	12.66 (4.43)	12.98 (4.17)	16.50 (4.57)	14.64 (4.32)	2.08 (0.76, 3.40)	0.00	0.01–0.10	0.47
Body mass index (kg/m^2)	16.80 (1.74)	16.57 (1.47)	16.70 (1.84)	16.56 (1.62)	-0.8(-0.33, 0.17)	0.53	0.60–0.74	0.46

* P vales adjusted using methods of Hedges [17] as outlines in the methods

** Standardized effect size (Cohen's d) expressed in standard deviation multiples to allow comparisons of effect sizes across different measures and studies, calculated as the adjusted difference between treatment and control groups divided by the pooled within group standard deviation.

Table 3 Changes in Physical Activity for Intervention and Control Groups

	Baseline		Follow-up		6-month differences			
	Intervention Mean (*SD*)	Control Mean (*SD*)	Intervention Mean (*SD*)	Control Mean (*SD*)	Adjusted I-C Difference (95% CI)	P value	P value Adjusted for ICC (0.01–0.05)*	Effect size (Cohen's d) **
	N = 52	*N* = 45	*N* = 52	*N* = 45				
Physical activity measures taken during intervention#								
Counts per minute	745 (241.45)	796 (221.58)	894 (308.98)	829 (246.51)	110.48 (33.62, 187.33)	0.01	0.03–0.16	0.40
% time being sedentary	82.20 (9.33)	80.92 (8.83)	78.62 (11.00)	78.24 (14.30)	-0.97 (-5.76, 3.82)	0.69	0.81–0.88	0.08
% time in light physical activity	10.83 (4.12)	12.04 (3.23)	14.15 (6.59)	14.83 (8.87)	-0.06 (-3.15, 3.02)	0.97	0.92–0.95	0.01
% time in moderate physical activity	2.91 (1.51)	3.31 (1.67)	3.85 (2.72)	4.21 (4.32)	-0.24 (-1.68, 1.21)	0.74	0.88–0.92	0.07
% time in vigorous physical activity	4.05 (7.98)	3.72 (8.18)	3.37 (4.15)	2.76 (3.27)	0.56 (-0.90, 2.02)	0.16	0.07–0.25	0.15
% time in moderate to vigorous physical activity	6.96 (8.14)	7.03 (8.42)	7.22 (5.64)	6.97 (6.24)	0.26 (-2.07, 2.60)	0.82	0.69–0.80	0.04
Physical activity measures taken during follow-up##								

(continued)

Table 3 *(continued)*

	Baseline		Follow-up		6-month differences			
	Intervention Mean (*SD*)	Control Mean (*SD*)	Intervention Mean (*SD*)	Control Mean (*SD*)				
	N = 52	*N* = 45	*N* = 52	*N* = 45	Adjusted I-C Difference (95% CI)	P value	P value Adjusted for ICC (0.01–0.05)*	Effect size (Cohen's d) **
Counts per minute	745 (241.45)	796 (221.58)	753 (229.87)	829 (246.51)	-38.31 (-104.39, 27.78)	0.25	0.55–0.84	0.16
% time being sedentary	82.20 (9.33)	80.92 (8.83)	82.64 (9.56)	78.24 (14.30)	4.16 (-0.68, 8.99)	0.09	0.36–0.55	0.34
% time in light physical activity	10.83 (4.12)	12.04 (3.23)	12.25 (6.13)	14.83 (8.87)	-2.01 (-5.02, 1.00)	0.19	0.37–.057	0.26
% time in moderate physical activity	2.91 (1.51)	3.31 (1.67)	3.06 (2.43)	4.21 (4.32)	-1.06 (-2.47, 0.34)	0.14	0.32–0.52	0.30
% time in vigorous physical activity	4.05 (7.98)	3.72 (8.18)	2.05 (1.35)	2.76 (3.27)	-0.71(-1.70, 0.28)	0.16	0.68–0.79	0.28
% time in moderate to vigorous physical activity	6.96 (8.14)	7.03 (8.42)	5.10 (3.65)	6.97 (6.24)	-1.86 (-3.89, .018)	0.73	0.36–0.55	0.36

* P vales adjusted using methods of Hedges (2007) as outlined in the methods

** Standardized effect size (Cohen's d) expressed in standard deviation multiples to allow comparisons of effect sizes across different measures and studies, calculated as the adjusted difference between treatment and control groups divided by the pooled within group standard deviation.

Physical activity measures during the intervention were only assessed on the intervention participants. For these analyses, the postintervention (follow-up) measures were used for the control group.

Physical activity measures were taken following the implementation of the program (i.e., one week after thze program had finished)

While a significant difference in BMI between groups was not observed, changes in BMI were greater for the intervention group compared with the control group. Medium effect sizes were reported for BMI (Table 2).

Discussion

The results show that *Jump Start* was feasible, acceptable and potentially efficacious. Our retention goals were exceeded. To date, very few studies have reported retention rates (28). Connor-Kuntz and Drummer (5) and Ignico (19) retained all participants at postintervention and Ignico retained 83% at 3-month follow-up, with Reilly and colleagues (27) retaining approximately 90% of participants at both 6- and 12-month follow-up. Our retention rates were consistent with these intervention studies. The high level of support offered by the Director and staff of the childcare center and the potential benefits of the program perceived by the parents may have contributed to these high retention rates. In addition, the relatively short duration of the intervention may have positively influenced retention rates.

The collection of the majority of outcome measures at baseline and follow-up can be attributed to multiple measurement sessions being conducted during standard center hours. The reasons for not collecting data at either baseline or follow-up included absenteeism or in a small number of instances, participants refusing to wear the activity monitor or participate in the movement skill testing. We suggest that working closely with the center staff is critical to overcome such situations and maximize data collection.

Implementation rates for the professional development and structured lessons were high. It is not possible to compare our implementation rates with other studies because, to the best of our knowledge, no other studies have reported such data. Despite this lack of evidence, there is strong evidence to suggest that positive, strong leadership is critical for implementation of new programs within organizations (18,30). In our study, the Director of the intervention center intentionally allocated time during the staff meetings for the professional development and modified the Centre's program to incorporate the structured lessons. Further, the Director strongly encouraged all staff members to be proactively involved in the program. Collectively, this meant that, over time, the structured sessions became routine. Moreover, staff suggested that participants consistently enjoyed the structured sessions, which further encouraged staff in their implementation.

Several factors may have contributed to the reasons why staff uniformly suggested that the content was highly appropriate. First, *Jump Start* was designed in response to extensive formative research (28) and a proof-of-concept feasibility study. Stevens and colleagues (32) strongly encourage a series of smaller studies to thoroughly test intervention components, including recruitment, appropriateness of content and delivery to maximize retention and achievement of outcomes. Second, all resource components were developed by trained professionals who understood the developmental stages of young children and their cognitive abilities. Third, the content was flexible in delivery, particularly in terms of the number of children who could participate in the structured lessons and the location (i.e., indoor and outdoor) in which the structured lessons could be implemented.

Positive feedback from the staff and the Director of the center demonstrated the acceptability of *Jump Start* among key stakeholders. Acceptability by stakeholders has been reported in studies targeting older participants (25). The engagement of stakeholders has been shown to be influential in the short- and long-term success of school-based interventions (17,40). Based on these findings with older children, we suggest that engaging key stakeholders overseeing preschool interventions may be as equally important for program success.

Our results for movement skill development are consistent with those reported by Goodway et al. (12), Goodway and Branta (11) and Hamilton et al. (13); that is, the improvements in individual skills (and by nature overall skill proficiency) was greater in the intervention group (Table 2). We compared our results with these studies as similar instruments were used. However, direct comparison of the individual skills is limited, as effect sizes for the above studies could not be calculated. The significant improvements in movement skills reported in our study could be a result of the *Jump Start* intervention only focusing on five movement skills. This meant that each skill was revisited twice, providing greater opportunities for the children to practice each skill. In addition, the structured lesson allowed facilitators to focus on the individual components of the skills. For those components that children found more difficult to master, staff had the knowledge (from the professional development sessions) and time to facilitate mastery. This may have been particularly true for the jump, where medium to large effect sizes were reported (Table 2). Mastery of the jump requires coordinated movement between the arms and the legs which young children often find difficult (10). However with direct instruction and adequate practice time, mastery can potentially be accomplished.

To date, very few interventions that include an objective measure of physical activity and target young children have been published. Of the two studies identified, one measured physical activity during preschool hours (33) and the other measured habitual physical activity (27). Trost and colleagues' (32) 8-week randomized controlled trial aimed to increase physical activity during normal preschool hours by modifying the preschool curriculum to include physical activity in all curriculum areas including maths and science. The intervention group participated in significantly higher levels of moderate-to-vigorous activity and vigorous activity (all $p < .05$) compared with the control group (33). Reilly et al. (27) reported small to medium effect size (0.39) for counts per minute following implementation of their 24-week group randomized controlled trial. Our physical activity data, collected in the last two weeks of the intervention are consistent with these results (counts per minute, $p < .01$, d= 0.40, Table 3). These results suggest that *Jump Start* was potentially effective, while being implemented, in changing physical activity behaviors of young children. In addition, our results highlight that an intervention implemented primarily by setting staff has the potential to ass significant to the amount of physical activity that preschool children obtain during the school day.

These initial results are encouraging, however, the changes were not maintained at follow-up (even though follow-up was within a month of finishing the program; Table 3). We suggest that cessation of the program is the most likely reason for the change in physical activity at follow-up. Despite all staff indicating strongly that they would continue to implement *Jump Start* following the trial period, it is likely that it did not continue to be taught due to conflicting end of year priorities

(such as the completion of children's learning portfolios). Further, staff may have been less motivated to continue implementing the program as the researcher was not present. These results highlight the very real barriers (e.g., conflicting priorities and motivation of staff) associated with medium to long-term sustainability of physical activity programs within the early childhood setting. We suggest that future studies incorporate relapse prevention components or longer follow-up periods to sustain changes (20).

In our study, trends toward decreases in BMI were greater in the intervention group compared with the control group, resulting in a medium effect size (Table 2). Few interventions targeting preschool children report changes in BMI (16,28): only five studies were identified that reported changes in BMI, with only one reporting significant changes in BMI (8). The Hip-Hop to Health cluster randomized controlled trial aimed to prevent obesity in minority 3–5 year-olds (8). It reported smaller BMI increases in the intervention group at both 1- and 2-year follow-ups ($p = .01$, $p = .02$, respectively). Although we report a medium effect size for BMI, our results should be interpreted with caution, as there are a number of additional unmeasured variables that could account for these changes. Future studies, with larger samples sizes and longer follow-up periods are needed to confirm our results. We suggest that based on our findings, an adequately powered efficacy trial with a similar design (i.e., group randomized controlled trial) would involve approximately 500 preschool children.

This study was implemented with high rigor and was of high methodological quality. In light of these strengths, a number of recommendations for future physical activity and motor development interventions delivered within childcare facilities can be made:

1. Strong leadership and support from key stakeholders are critical for program fidelity. A leader/director must encourage staff involvement and be being willing to modify usual programs and policies to accommodate the implementation of ongoing professional development and structured physical activity sessions.
2. Intervention success is somewhat dependent on the ability of childcare staff to incorporate the intervention into their normal routine. That is, designated times must be allocated for physical activity and staff must be aware of when and how these sessions will occur.
3. Interventions should incorporate a sustainability component, to ensure implementation following cessation of the formal intervention period. Long-term behaviors changes are more likely to result from ongoing implementation (21).

Study Strengths and Limitations

This study has two main strengths. First, it is a true pilot randomized controlled trial that employed trained blinded assessors and validated instruments and objective measures of physical activity. Second, it addressed many of the recommendations for practice highlighted in a recent systematic review (28). Specifically, our intervention was longer than past interventions, potentially enhancing the efficacy of the program. Further, setting staff implemented the majority of the program, potentially increasing the sustainability of the program, although we acknowledge

that relapse prevention strategies will need to be considered in future studies. Only one other study was identified that involved setting staff implementing the majority of the intervention (27). Finally, our study was of high methodological quality and aligned closely with recommendations from the extended CONSORT statement for group randomized controlled trials (1,2).

The main limitation of this study was the sample size, although our sample size was comparable with other studies (11,12,36). This meant that the study was not powered to detect statistical significance and we were not able to report trends for boys and girls separately. This study was intentionally designed as a pilot randomized controlled trial with overall aims of reporting trends in outcomes and feasibility and acceptability outcomes to inform larger studies. Another limitation of this study is the follow-up period (6 months). Longitudinal studies are needed to confirm long-term mastery of fundamental movement skills and time spent in physical activity. Furthermore, we acknowledge that physical activity data would need to be collected over a longer period to determine habitual change rather than setting change. In addition physical activity data would also need to be collected in the final two weeks of the program to allow accurate comparison with the intervention group.

Conclusion

This study contributes to the dearth of feasibility and acceptability data available the published literature and addresses many of the limitations in other preschool interventions. In addition, it shows that a physical activity program delivered by staff within the preschool setting is potentially efficacious. These encouraging results will inform the design, development and implementation of a larger full-scale efficacy trial.

Acknowledgments

The authors would like to thank the participating children and staff. A University of Wollongong Faculty Grant supported this study. KH is supported by a National Heart Foundation of Australia Career Development Grant.

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