



Original paper

Fundamental movement skills among Australian preschool children

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Abstract

Early childhood is a critical period for the development of fundamental movement skills (FMS). Children who do not master FMS are more likely to experience failure in the motor domain and less likely to participate in sport and games during childhood and adolescence. Studies among primary school aged children report low levels of FMS mastery indicating the need to implement FMS programs during the preschool years. Cross-sectional study of 425 children attending preschools in the Sydney, Australia in 2008. FMS were assessed using the Test of Gross Motor Development-2 including locomotor (run, gallop, hop, horizontal jump) and object control (strike, catch, kick overhand throw) skills. Data were analysed using linear regression and chi-squared analyses. Total locomotor score was higher among girls compared with boys ($p < 0.00$); however only the hop was significantly different ($p = 0.01$). Boys had higher total ($p < 0.00$) and individual object control scores compared with girls, except the catch ($p = 0.6$). The prevalence of mastery differed across each FMS. Girls generally had higher mastery of locomotor skills and boys had higher mastery of object control skills. These findings highlight the need to provide structured opportunities which facilitate children's acquisition of FMS, which may include providing gender separated games, equipment and spaces. That mastery of FMS is low in primary school children indicates the importance of early intervention programs in preschools. Preschools and child care centers hold promise as a key setting for implementing FMS programs.

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1. Introduction

Preschool and the early elementary years are critical to a child's development and mastery of fundamental movement skills (FMS). The acquisition of FMS are developmentally sequenced¹ and are contingent upon multiple internal and external factors (biological, psychological, social, motivational, cognitive, etc.) and the process of acquisition occurring through a range of active play experiences and structured programs. These skills allow children to interact and explore their environment.² Furthermore, research among school aged children^{3–6} shows that mastery of FMS is correlated with higher levels of physical activity, and there is emerging evidence among preschoolers that FMS,⁷ and

in particular locomotor skills⁸ are also positively associated with physical activity.

Basic descriptive epidemiological information on FMS among preschool aged children (i.e., 2–5 years) is limited. Studies among primary school aged children indicate low levels of FMS mastery^{9,10} and given that children with low FMS competence are less likely to participate in and enjoy many physical activities compared with their skilled peers,⁶ it appears prudent to examine FMS in preschool aged children. Socio-demographic differences in FMS have been noted in school aged children, albeit inconsistently. There is some evidence which suggests socioeconomic status was positively associated with FMS among girls^{9,11} and children from non-English-speaking backgrounds had lower levels of FMS mastery.^{12,13}

Over 56% of 4-year-old Australian children attend preschool¹⁴ indicating that this sector could be a key setting for intervention programs. Preschool years are an optimal

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time to introduce FMS because movement patterns are not entrenched. Therefore, early childhood programs can play a key role in promoting opportunities for young children to routinely practice a range of FMS through structured activities and free play.

In order to establish relevant and sustainable programs which focus on FMS development within the early childhood sector detailed information about the acquisition and mastery level of preschool aged children is required. Ideally, a holistic assessment of FMS incorporates locomotor, manipulative (object control) and stability skills.² In this study the Test of Gross Motor Development-2 (TGMD-2)¹⁵ protocols were used to examine a subset of locomotor and manipulative skills which are related to activities and games in which children are most likely to participate during the preschool years. Stability, which measures balance skills, occurs very early in development and because ceiling effects may be observed was not assessed in this study.

The TGMD-2 is a criterion- and norm-referenced instrument designed to assess gross motor development among children aged between 3.0 and 10.11 years. It is a valid and reliable (test–retest reliability = 0.88–0.96) process-orientated test which is used for FMS research among young children. Process-oriented tests assess whether the form of the movement skill incorporates the observed performance criteria in a mature pattern and therefore more accurately identify specific characteristics of the movement which reflect the developmental skill level rather than the physical growth and maturational levels of children.

Given the lack of basic descriptive information on preschooler's FMS, the primary purpose of this study was to describe the prevalence and socio-demographic distribution of FMS and secondly to describe the performance criteria of each skill among 4-year-old children attending preschool in the Sydney area of New South Wales (NSW), Australia.

2. Methods

All preschools that were operated under the auspices of the NSW Department of Education in the Sydney, Western Sydney and South Western Sydney regions of NSW were invited to participate in the study. Children and their parents were recruited from those preschools which agreed to participate. Data were collected between May and June 2008. Informed consent by the child's parent or guardian was a requirement for participation and ethics approval was given by The University of Sydney Human Research Ethics Committee.

Parents completed a survey which included information on their child's sex, date of birth, postcode of residence and the main language spoken at home. Postcode of residence was used as a proxy for socioeconomic status (SES), based on the Australian Bureau of Statistics' Index of Relative Socioeconomic Disadvantage (IRSD),¹⁶ and was used to rank students in tertiles of SES (low, medium or high). The IRSD describes the socioeconomic aspects of geographical

areas and includes indices on income, educational attainment, unemployment and proportion of people in unskilled occupations. Language spoken most at home was used to categorize students into English-speaking and non-English-speaking backgrounds (NESB).¹⁷

Eight FMS were assessed; four locomotor skills (run, gallop, hop, horizontal jump) and four object control skills (striking a stationary ball, catch, kick, overhand throw) using the Test of Gross Motor Development-2 (TGMD-2).¹⁵ The TGMD-2 comprises sub-tests which assess locomotor skills which measure the coordinated movement of the centre of gravity from one point to another and object control skills which measure the projecting and receiving of objects. These skills were selected for assessment because they facilitate the development of more advanced movement skills.

Each skill comprises 3–5 performance criteria which are scored as either present or absent and scored over two test trials. Scores for each child were calculated by totaling the correctly performed criteria for two trials for each skill (i.e., if a skill comprises three performance criteria the score range is 0–6). The maximum sub-test scores for locomotor and object control skills were 38 and 32, respectively, with a minimum of 0. The sum of both sub-tests yielded the total gross motor skill score (total FMS). Raw scores were used in the data analysis as this is recommended for research purposes.¹⁵ Skill mastery was determined when the child correctly demonstrated each performance criteria of the skill on both trials.

Prior to testing the field team were trained on the administration of the TGMD-2 by two of the authors (LH, RM) who have experience in FMS assessment. The inter-rater reliability, determined by the intra-class correlation coefficient, was 0.9 for the total test. The children were tested in small groups (one assessor per child) in an outside area and each skill was demonstrated prior to testing including providing a verbal description of the skill. The children were allowed to practice each skill before being scored on the two test trials. If an assessor was unsure about a child's performance on a skill the child was asked to repeat the skill and the other assessors were consulted. The child was then scored according to agreement among the assessors. There was no specific order to administer the tests and a standard scoring sheet was used to record each child's performance.

Data were analysed using SPSS Complex Samples (version 16) to account for the clustered design of the study and adjust for the standard errors and 95% confidence intervals. The CSPlan procedure was used to allow for stratification by education region and clustering within preschools and the data were analysed using general linear models (CSGLM). For the analysis, SES and language backgrounds were dichotomized into low and middle/high SES groups and English-speaking and non-English-speaking backgrounds (NESB). Descriptive statistics including proportions and means based on raw scores were used to describe the mastery of FMS separately for boys and girls. Statistical significance was set at $p < 0.05$.

Table 1

Mean (SE) score and prevalence (%) and 95% confidence intervals (95% CI) of mastery of fundamental movement skills among boys ($n = 171$) and girls ($n = 159$).

Fundamental movement skills	Score ($M \pm SE$)		p -Value	Mastery (%; 95%CI)	
	Girls	Boys		Girls	Boys
Locomotor skills					
Run	7.34 (0.13)	7.44 (0.01)	0.49	69% (61, 78)	76% (67, 85)
Gallop	5.06 (0.33)	4.38 (0.44)	0.13	36% (28, 44)	28% (16, 39)
Hop	6.32 (0.39)	5.02 (0.44)	0.01	29% (18, 39)	21% (11, 31)
Horizontal jump	4.92 (0.33)	4.55 (0.25)	0.6	23% (10, 36)	21% (12, 31)
Sub-test score	23.86 (0.85)	21.49 (1.02)	0.005	5.8% (4.7, 7.0)	4.2% (3.1, 5.3)
Object control skills					
Strike	6.00 (0.19)	7.08 (0.18)	0.001	6% (2, 10)	20% (13, 26)
Catch	3.97 (0.14)	4.06 (0.15)	0.6	18% (10, 26)	22% (14, 30)
Kick	5.21 (0.29)	6.14 (0.24)	0.002	22% (15, 32)	44% (34, 54)
Overhand throw	3.13 (0.29)	3.92 (0.25)	0.01	9% (4, 13)	23% (15, 30)
Sub-test score	18.45 (0.50)	21.20 (0.54)	0.000	3.3% (2.4, 4.2)	3.3% (2.4, 4.3)
Total FMS score	42.64 (1.19)	42.83 (1.50)	0.87	–	–

3. Results

Sixty-one preschools were invited to participate in the study and 29 agreed to be involved. From the eligible preschools, consents were obtained from the parents of 425 children (54% response rate) aged between 2.1 and 6.1 years (mean 4.4 years; $SD \pm 0.4$) and FMS were assessed on 412 children (97%). Thirteen children declined to participate in FMS assessment.

The results for only children aged between 4.0 and 4.9 years ($n = 330$) are presented because of the small numbers in the other age groups. This sample comprised 52% boys, with the majority (56%) of children from low SES families and 49% from non-English-speaking backgrounds. On average, these children spent 3.7 days per week at preschool.

The majority of preschools allocated time each day for structured (93%; mean time 21.8 min, range 10–150 min) and unstructured active play (100%; mean time 66.7 min, range 15–150 min) and 59% allocated specific time to teach FMS (mean time 10.2 min, range 5–45 min).

The mean skill score (SE) and the prevalence (%; 95%CI) of mastery among boys and girls are shown in Table 1. Overall, girls had a higher total locomotor score compared with boys; however there were no gender differences between mean locomotor scores for each skill except for the hop ($p = 0.01$). Boys had higher total object control score compared with girls and had higher scores for each object control skill compared with girls, except for the catch ($p = 0.6$). There was no difference in the composite FMS score (i.e., locomotor and object control) between boys and girls ($p = 0.87$).

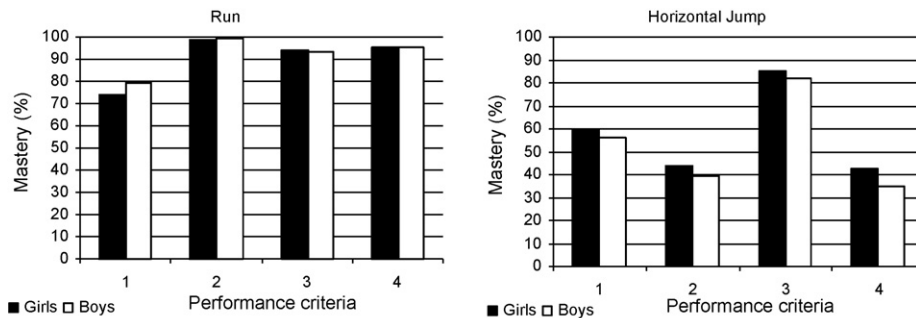
The prevalence of mastery differed across FMS. Almost 75% of children demonstrated mastery of the run, while the proportion of children who possessed mastery was lower for the kick (35%), gallop (31%), hop (25%), jump (22%), catch (20%), throw (16%) and strike (14%). Compared with girls, the prevalence of mastery was significantly higher among boys for the strike ($p = 0.001$), kick ($p = 0.001$) and over arm throw ($p = 0.003$).

There were no significant differences in mastery of individual FMS according to SES or language background among children, except the hop among boys. A higher proportion of boys from middle/high SES demonstrated mastery of the hop compared with low SES boys (31% vs. 13%, $p = 0.005$) and boys from non-English-speaking backgrounds compared with boys from an English-speaking background (29% vs. 15%, $p = 0.03$).

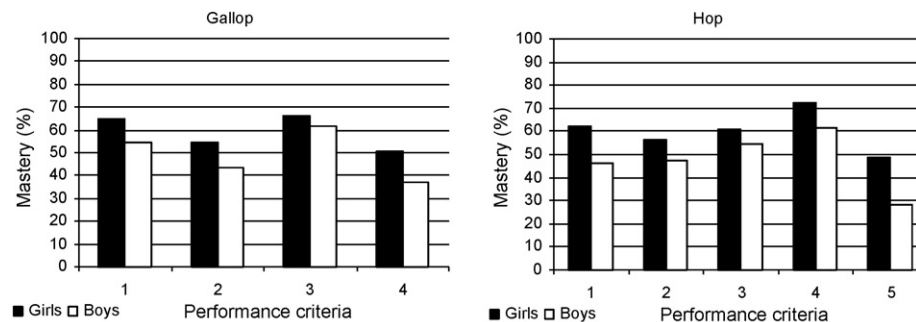
Figs. 1 and 2 show the proportion of boys and girls who demonstrated mastery by performance criteria for each locomotor and object control skill, respectively. In respect to the subset of locomotor skills, a higher proportion of children demonstrated mastery of performance criteria which involved only leg movements, compared with demonstrating mastery for stability (balance) orientated performance criterions of the skill, where this involved coordinating trunk and arm movements (e.g., performance criterion 2 and 4 in the jump; 1 and 5 in the hop). Similarly, the performance criteria in the subset of object control skills which have lower levels of mastery involve more complex, transitional coordination of the trunk (e.g., performance criterion 2 in the kick), transferring weight (e.g., performance criterion 4 in the strike; 2–4 in the throw) and dexterity (e.g., performance criterion 3 in the catch).

4. Discussion

The findings from this study showed that the acquisition of FMS among 4-year-old preschoolers differed across skills and by gender. The majority (70–75%) of children demonstrated mastery of the run while the prevalence of mastery for the remaining FMS among boys and girls ranged between 9% and 44%. Overall, girls tended to have higher mastery of locomotor skills and boys higher mastery of object control skills. While previous research has shown that SES and language background was positively associated with mastery of some FMS among school aged children^{9,11} the only signifi-



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|---|---|
| <ol style="list-style-type: none"> 1. Arms move in opposition to legs, elbows bent. 2. Brief period where both feet are off the ground. 3. Narrow foot placement landing on heel or toe (i.e. not flat footed). 4. Non-support leg bent approximately 90 degrees (i.e. close to buttock). | <ol style="list-style-type: none"> 1. Preparatory movement includes flexion of both knees with arms extended behind the body. 2. Arms extended forcefully forward and upwardreaching full extension above the head. 3. Take off and land on both feet simultaneously. 4. Arms are thrust downward during landing. |
|---|---|



- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Arms bent & lifted to waste level at takeoff. 2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot 3. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot 4. Maintains a rhythmic pattern for four consecutive gallops. | <ol style="list-style-type: none"> 1. Non-support leg swings rhythmically forward and backward in pendular fashion to produce force. 2. Foot of non-support leg remains behind the body. 3. Arms flexed & swing forward to produce force 4. Takes off & lands 3 consecutive times on preferred foot. 5. Takes off & lands 3 consecutive times on non-preferred foot. |
|---|---|

Fig. 1. Proportion (%) of boys and girls who demonstrated mastery of each performance criteria for the locomotor skills.

cant socio-demographic differences in this study was among boys for the hop.

While the research on FMS in the preschool age cohort is emerging, there is some evidence that proficiency in motor skills at this age is positively associated with physical activity participation.^{7,8} Importantly, research on older children shows that FMS track at low-to-moderate levels during childhood and are posited to have some predictive value for physical activity during adolescence.^{1,18} For this reason, descriptive information on the acquisition and mastery of individual FMS, and the performance criteria of each skill component are required and to assist plan appropriate and relevant programs to improve FMS proficiency among preschool aged children.

In this study boys performed better than girls on the object control skills, which is consistent with findings among pri-

mary school children.^{9,19} However, prior to puberty, boys and girls are very similar physically with little differences in biological characteristics including body type, body composition, strength, and limb lengths²⁰ which suggests biology does not fully explain sex differences in skill performance among preschool aged children.²¹ Gender differences are therefore more likely to be associated with children's socialization which is influenced by family, peers and teachers.^{21,22}

From an early age interactions among girls tend to be conducted in a cooperative, caring and shared manner while among boys interactions are marked by competitiveness, individualism and egocentrism.^{22,23} These traits potentially reflect the differences in games and play interactions between boys and girls and a lack of skill practice could be a critical factor in the development and acquisition of some of these movement skills among girls.²²

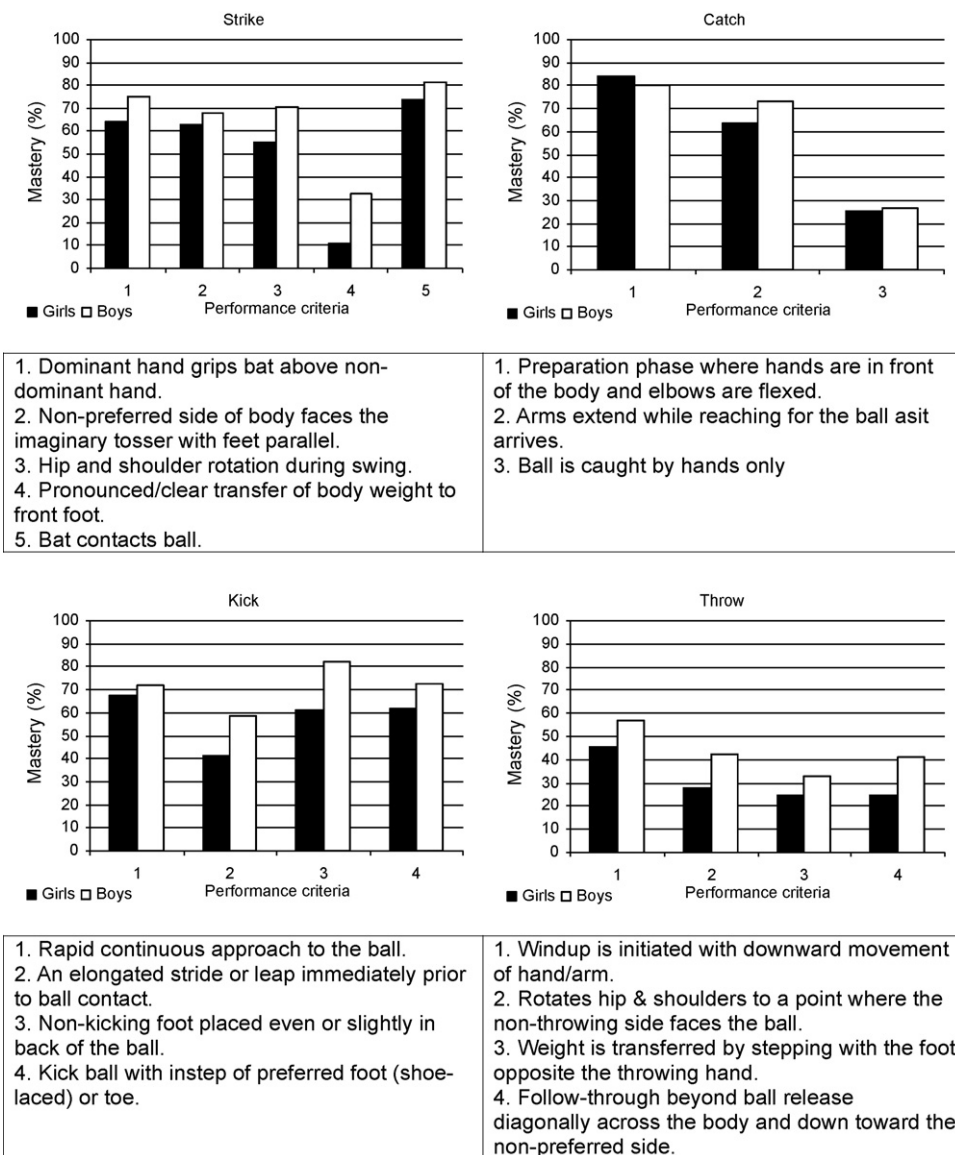


Fig. 2. Proportion (%) of boys and girls who demonstrated mastery of each performance criteria for the object control skills.

Information on gender differences in FMS can help preschools and parents identify which skill should be targeted so that both boys and girls are given the opportunity to practice and learn skill basics before starting primary school. The efficacy of a preschool and home-based FMS program has been examined²⁴ and showed that targeted programs can improve FMS among boys and girls.

Our findings on the mastery of individual performance criteria were consistent with children’s developmental progress and showed the continuum of skill acquisition, where rudimentary locomotor movements are mastered prior to more complex manipulative actions which require coordination and stability of trunk and limb movements in order to master the skill. The different rates of performance criteria mastery indicate the value of teaching each skill component individually and providing children with opportunities to repeat the action on multiple occasions

in order to gain skill mastery. Although children should be provided with opportunities to practice FMS during free play, evidence indicates that teacher directed activities lead to greater improvements in children’s FMS proficiency.^{25,26}

The strengths of this study were that it was conducted among a large representative sample of 4-year-old children attending state-run preschools across a range of socioeconomic areas and ethnic backgrounds. Furthermore, FMS were assessed by trained field workers using a process-oriented technique which provides a guide for determining acquisition of a skill by each component. The main limitations of the study were the cross-sectional design, so that the direction of associations can not be determined and the low response rate, which was primarily due to parents forgetting to return consent forms: there was no evidence of systematic non-response bias.

5. Conclusions

The preschool environment plays an important role to foster and develop children's FMS. The current findings highlight the need for teachers to provide structured opportunities which facilitate children's development and confidence in FMS, which may include providing gender separated games, equipment and spaces. Playing games that are fun, inclusive and skill-based will help prepare children to participate in a wide variety of physical activities with greater success and enjoyment. Investments in FMS programs during early childhood are important because they have the potential to enable children to participate successfully in games and sports during adolescence and adulthood, and once learned the skills are retained for life.

6. Practical implications

- Preschool teachers and parents need to demonstrate separately each FMS performance criteria and provide opportunities for the child to practice the skills.
- Preschool teachers need practical resources and professional development on the development of FMS in order to plan instructional activities which help children master the performance criteria of each skill, and lead to skill mastery.
- Preschools and parents need to provide dedicated spaces and equipment (i.e., bats and balls), to help facilitate girls' development of object control skills and activities which encourage boys to practice locomotor skills.

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