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Prevalence and Correlates of Low Fundamental Movement Skill Competency in Children

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Pediatrics; originally published online July 23, 2012;
DOI: 10.1542/peds.2012-0345

Prevalence and Correlates of Low Fundamental Movement Skill Competency in Children

WHAT'S KNOWN ON THIS SUBJECT: Children's mastery of fundamental movement skills is correlated with a number of health benefits, including higher levels of physical activity, cardiorespiratory fitness, perceived scholastic and athletic competence, and lower levels of overweight.

WHAT THIS STUDY ADDS: This is the first study to examine the associations between low skill competence (a new and novel way to report motor skills) and a range of health-related and sociodemographic factors in a large representative sample of children and youth.

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KEY WORDS
fundamental movement skills, fitness, physical activity, ethnicity, BMI

ABBREVIATIONS
CI—confidence interval
FMS—fundamental movement skills
NSW—New South Wales
OR—odds ratio
SES—socioeconomic status

Drs Hardy and Okely were responsible for conception and design of study; Drs Hardy and Okely and Mrs Espinel were responsible for acquisition of data; Drs Hardy and Zask and Ms Reinten-Reynolds and Mrs Espinel were responsible for analysis and interpretation of data; all authors were responsible for revising the article for important intellectual content and gave final approval of the version to be published.

www.pediatrics.org/cgi/doi/10.1542/peds.2012-0345

doi:10.1542/peds.2012-0345

Accepted for publication Apr 5, 2012

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

FUNDING: Funded by the NSW Ministry of Health.

abstract

OBJECTIVE: To describe the demographic and health-related characteristics of school-aged children with low competency in fundamental movement skills (FMS).

METHODS: Cross-sectional representative school-based survey of Australian elementary and high school students (n = 6917) conducted in 2010. Trained field staff measured students' height, weight, and assessed FMS and cardiorespiratory endurance (fitness). Information on students' demographics and physical activity was collected by questionnaire.

RESULTS: Overall, the prevalence of students with low motor skill competency was high. Girls with low socioeconomic status (SES) were twice as likely to be less competent in locomotor skills compared with high SES peers. Among boys, there was a strong association between low competency in FMS and the likelihood of being from non–English-speaking cultural backgrounds. There was a clear and consistent association between low competency in FMS and inadequate cardiorespiratory fitness. For boys, there was a clear association between low competency in object-control skills and not meeting physical activity recommendations. Conversely, the odds of being inactive were double among girls who had low competency in locomotor skills.

CONCLUSIONS: Low competency in FMS is strongly associated with lower cardiorespiratory fitness and physical activity levels in children and adolescents. The characteristics of students with competency in FMS differ by gender and skills types and show that interventions need to target girls from low SES backgrounds and boys from non–English-speaking cultural backgrounds. The high prevalence of low competency in FMS among Grade 4 students indicates that FMS interventions need to start during the preschool and early school years. *Pediatrics* 2012;130:e390–e398

Fundamental movement skills (FMS) are the building blocks for movement and they form the foundation for many of the specialized skills required in popular sports and leisure activities.[1] Furthermore, research shows that developing FMS during childhood may be an important step toward establishing a lifelong commitment to physical activity[2] and, importantly, that mastery of FMS among school-aged children is correlated with a number of health benefits, such as higher levels of physical activity, cardiorespiratory fitness, perceived scholastic and athletic competence, and lower levels of overweight.[3]

A common misconception is that children "naturally" learn FMS; however, children need to be taught these skills and provided with opportunities to practice them through developmentally appropriate activities. The acquisition of FMS is developmentally sequenced,[4] and contingent on multiple internal and external factors (biological, psychological, social, motivational, cognitive, and so forth) and the process of acquisition occurs through a range of active play experiences and structured programs. It has been suggested that it takes between 240 and 600 minutes of instruction time to master an FMS.[5] Most children are developmentally able to master most of the less-complex FMS, including sprint run, vertical jump, catch, side gallop, and over-arm throw by ~age 6 (Grade 2)[1] and several of the more complex FMS, including the leap and kick by the end of Grade 4.[6]

The prevalence of FMS mastery among children and adolescents is low,[7–9] and more recently, the evidence indicates that mastery of FMS among young people is declining.[10] Children who have not been able to master basic FMS are more likely to not participate in organized sports and play experiences with their friends because of a lack of basic physical skills.[11] Identifying the characteristics of children who do not demonstrate mastery of FMS is important for the development of appropriate interventions to equip those children who are at risk for not reaching their potential to engage in physical activities. The aim of this study was to examine the characteristics of school-aged children and adolescents who have low competency in FMS, including biological factors (sex, age, weight status), sociodemographic factors (socioeconomic status [SES], cultural background), and physical activity outcomes (cardiorespiratory fitness, physical activity participation) among a large representative sample of Australian elementary and high school students.

METHODS

The New South Wales (NSW) Schools Physical Activity and Nutrition Survey 2010 was a representative cross-sectional school-based survey of more than 8000 elementary and high school students in NSW, Australia, conducted between February and April 2010. Data were collected by trained field staff who were required to reach 99% interobserver agreement for anthropometry measures and 80% interobserver agreement for FMS assessment against precoded videotapes. A detailed description of the survey method has been published elsewhere.[12]

Briefly, parents of students in Grades 2 and 4 were asked to complete a questionnaire on behalf of their child and return it with the signed consent, whereas students in Grades 6, 8, and 10 completed the same questionnaire during a school visit. Written consent by students and their care providers was a requirement for participation. The University of Sydney Human Research Ethics Committee, the NSW Department of Education and Training, and the NSW Catholic Education Commission approved the survey.

Demographic information on the student included gender, date of birth, postcode of residence, and language spoken most at home. Postcode of residence was used as a proxy for SES, based on the Australian Bureau of Statistics' Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage.[13] SEIFA summarizes a variety of census-obtained socioeconomic indicators for geographic areas, including income, educational attainment, unemployment, and proportion of people in unskilled occupations and was used to rank students in tertiles of SES (low, medium, or high) and to determine locality (rural or urban), by using the Accessibility/Remoteness Index of Australia.[14] Language spoken most at home was used to categorize students into English-speaking and non–English-speaking backgrounds.[15] Height and weight were measured and BMI calculated, and students' BMIs were categorized according to international cut-points.[16]

Seven FMS were assessed among students: 4 locomotor skills (sprint run, vertical jump, side gallop, and leap) and 3 object-control skills (catch, over-arm throw, and kick) by using process-oriented checklists for each skill.[6] These skills were selected because they are the foundation for sports and games that are popular among school-aged children (eg, ball sports, dance, and gymnastics).[11] Skill proficiency was assessed by field staff scoring each component of each skill as present or absent. If the student demonstrated the skill component consistently (ie, 80% of skill components) they were recorded as possessing that skill component. The number of components of each skill correctly demonstrated by each student was summed to give a score for each skill. Students were categorized as having mastery if they demonstrated all, or all but 1, component of a skill, or nonmastery (ie, low competency) when this criterion was not met.[9]

We also sought to assess the proportion of students with overall low competency in object-control or locomotor skills. Students who did not demonstrate mastery in at least 2 of the 3 object-control and in at least 3 of the 4 locomotor skills were categorized as having low competency of object-control and locomotor skills, respectively.

The 20-m shuttle run test[17] was used to assess cardiorespiratory endurance (ie, fitness) among Grades 4, 6, 8, and 10. Students were required to run and shuttle back between 2 lines placed 20 m apart, at increasing speeds. Scores were recorded as the level and shuttle reached in the test, converted to the number of laps completed, and then students were categorized as adequately fit or not adequately fit by using the criterion-referenced standard from Fitnessgram.[18]

Questions from the NSW Population Child Health Survey were used to collect information on physical activity among students in Grades 2 and 4.[19] Parents reported the frequency and duration of organized games, sports, and dance and nonorganized physical activities in which their child usually participates, separately for weekdays (outside of school hours) and for weekends. The sum of time spent in organized and nonorganized physical activity was calculated (minutes/day) and the prevalence of meeting physical activity recommendations determined (ie, ≥60 minutes daily).[20,21] Students in Grades 6, 8, and 10 completed the validated Adolescent Physical Activity Recall Questionnaire.[22] Briefly, students report organized and nonorganized activities in which they participated, and the frequency and the average duration for each activity in which they participated during summer school terms. The sum of time spent in organized and nonorganized physical activity was calculated and the prevalence of meeting physical activity recommendation determined.[22]

Poststratification weights were calculated and data analyses were performed by using SAS version 9.2 (SAS Institute Inc, Cary, NC). All proportions and calculations were done on weighted values and only the weighted proportions are reported. Because FMS are developmentally sequenced, the data were reported by school grade for Grades 2, 4, and 6 and combined for high school students (Grades 8 and 10). A summary of student characteristics by school grade and gender were tabulated and included students' adherence to the physical activity guidelines, cardiorespiratory fitness, BMI category (not overweight/obese or overweight or obese), locality (urban, rural), SES tertile, cultural background (English-speaking or non–English speaking), and the prevalence of low competency in FMS.

The associations between low competency in FMS and physical health outcomes (fitness and physical activity) and sociodemographic factors (locality, SES, cultural background, and BMI category) were assessed by using SURVEYLOGISTIC procedures in SAS version 9.2 (SAS Institute Inc, Cary, NC) to calculate odds ratios (ORs) to allow for stratification by education sector and clustering within schools and analyzed by gender and school grade.

RESULTS

In total, 6917 students participated, and the survey response rates were 60.0% and 52.2% for elementary and high school students, respectively. Overall, 53.0% of the students were boys, 23.2% were overweight or obese, and most were from middle to high SES tertiles (74.1%), urban areas (85.8%), and English-speaking backgrounds (83.3%). Non–English-speaking students were predominately from Asian (8.4%) and Middle Eastern (3.6%) cultural backgrounds. The characteristics of the sample are given in Table 1 and show that the prevalence of meeting physical activity recommendations and of adequate fitness was higher among boys.

The correlation between the composite object control and locomotor skills were small for elementary and high school students (Spearman $r = 0.13$ and $r = 0.14$, $P < .001$, respectively). The prevalence of low competency in both FMS subsets (ie, 0/7 skills) was consistently higher among girls. The prevalence of low competency in object-control skills was higher among girls, whereas there was little difference in prevalence of low competency in locomotor skills between boys and girls.

Most Grade 4 girls had low competency in the over-arm throw (89.4%) and kick (92.0%), whereas approximately one-third (31.8%) demonstrated low competency in the gallop. Among Grade 4 boys, there was high prevalence of low competency in the leap (86.9%), vertical jump (67%), and kick (57.5%), whereas just over one-third had low competency in the catch.

Tables 2 and 3 show there was a clear and consistent association between low competency in FMS and inadequate cardiorespiratory fitness. Boys with low competency in FMS were ~3 to 7 times, and girls 2 to 6 times, more likely to be unfit. These findings were consistent across individual object-control and locomotor skills. Similarly, among boys there was a significant association between low competency in object-control skills and not meeting the physical activity recommendations, and Grade 4 and high school boys showed low competency in locomotor skills, specifically the sprint run. A different pattern emerged among girls. High school girls who did not meet the physical activity recommendations were less competent in object-control skills, but girls in general with low competency in locomotor skills were twice as likely to be inactive.

TABLE 1 Characteristics of the Sample by School Grade/Level and Gender (n = 6917)

	Elementary School						High School	
	Grade 2		Grade 4		Grade 6		Grade 8 and 10	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Participants, *n*	616	632	697	699	649	631	1661	1332
Mean age in grade, y (SE)	7.3 (0.04)	7.3 (0.04)	9.3 (0.03)	9.2 (0.03)	11.3 (0.04)	11.2 (0.04)	14.4 (0.04)	14.3 (0.05)
Urban, %	88.7	87.3	87.6	88.2	84.2	88.6	81.1	80.3
SES, %								
Low	29.5	30.7	28.3	29.8	25.3	28.8	23.8	25.1
Middle	41.9	42.5	43.4	44.9	44.0	43.3	35.1	39.1
High	28.6	26.9	28.4	25.3	30.7	27.9	41.1	35.8
BMI category, %								
Overweight/obese	21.5	22.6	25.9	29.1	29.8	24.0	24.2	19.7
Cultural background, %								
English-speaking	84.9	79.5	83.7	81.0	82.6	83.8	86.7	87.9
Physical activity, %								
Meets recommendation	52.3	41.7	54.5	42.1	60.5	55.9	67.9	58.5
Adequate fitness	n	n	56.9[a]	68.7[a]	69.5	76.3	66.6	66.5
Low competency in FMS, %								
Low competency in all FMS (0/7)	92.6	n	78.0	98.3	65.6	96.0	46.4	93.1
Object-control skills (≤2/3 skills)	53.8	92.0	35.0	78.8	26.0	63.1	14.4	58.3
Locomotor skills (≤3/4 skills)	89.8	88.3	79.1	74.2	69.4	62.9	50.7	49.5

n, not tested.

[a] Of those aged 10 and over in this grade.

TABLE 2 Health-related Factors Associated With Low Competency in FMS Among Boys[a]

Boys	Grade 2	Grade 4	Grade 6	High school
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Unfit versus adequately fit[b]				
Object-control skills; low competency (≤2/3 skills)	—	21.03* (2.74–161.45)	4.94* (2.73–8.92)	3.20* (2.22–4.63)
Over-arm throw	—	2.54 (0.62–10.49)	1.88* (1.27–2.79)	2.37* (1.66–3.38)
Kick	—	3.35* (1.11–10.15)	3.11* (2.14–4.52)	3.45* (2.52–4.72)
Catch	—	3.02 (0.76–12.06)	2.73* (1.71–4.35)	2.63* (1.55–4.46)
Locomotor skills; low competency (≤3/4 skills)	—	14.78* (2.28–95.92)	6.91* (3.68–12.99)	2.72* (1.89–3.92)
Sprint run	—	1.93 (0.66–5.68)	4.69* (2.89–7.59)	3.16* (2.23–4.49)
Vertical jump	—	12.67* (2.45–65.6)	3.47* (2.13–5.65)	2.33* (1.62–3.34)
Side gallop	—	4.00 (0.82–19.49)	3.47* (2.12–5.67)	2.69* (1.82–3.99)
Leap	—	1.47 (0.33–6.50)	4.36* (1.98–9.60)	1.99* (1.48–2.66)
Does not meet physical activity recommendation versus meets recommendation				
Object-control skills; low competency (≤2/3 skills)	1.86* (1.09–3.20)	1.91* (1.16–3.13)	1.74* (1.07–2.85)	2.42* (1.66–3.52)
Over-arm throw	1.44 (0.92–2.26)	1.95* (1.32–2.86)	1.32 (0.81–2.16)	2.05* (1.52–2.77)
Kick	n	3.35* (1.11–10.15)	3.11* (2.14–4.52)	3.45* (2.52–4.72)
Catch	1.81* (1.22–2.67)	2.04* (1.52–2.73)	1.36 (0.87–2.14)	1.89* (1.26–2.82)
Locomotor skills; low competency (≤3/4 skills)	1.36 (0.84–2.22)	2.24* (1.46–3.44)	1.41 (0.90–2.21)	1.40* (1.11–1.77)
Sprint run	1.04 (0.70–1.55)	2.00* (1.32–3.03)	1.39 (0.87–2.21)	1.45* (1.09–1.93)
Vertical jump	1.18 (0.83–1.69)	2.19* (1.53–3.12)	1.34 (0.96–1.85)	1.19 (0.97–1.46)
Side gallop	1.11 (0.72–1.72)	2.25* (1.63–3.10)	1.11 (0.68–1.8)	1.58 (0.98–2.56)
Leap	1.28 (0.62–2.62)	1.30 (0.84–2.04)	1.30 (0.74–2.29)	0.97 (0.73–1.30)
Overweight or obese versus not overweight/obese				
Object-control skills; low competency (≤2/3 skills)	1.79 (0.89–3.61)	2.22* (1.51–3.28)	1.36 (0.82–2.25)	1.24 (0.75–2.07)
Over-arm throw	1.99 (0.96–4.12)	1.70* (1.22–2.39)	1.36 (0.82–2.26)	1.43* (1.03–1.98)
Kick	1.28 (0.74–2.20)	1.93* (1.34–2.79)	1.18 (0.73–1.91)	1.44* (1.02–2.03)
Catch	1.01 (0.67–1.52)	1.45 (0.97–2.16)	1.31 (0.78–2.21)	1.06 (0.65–1.74)
Locomotor skills; low competency (≤3/4 skills)	2.90* (1.11–7.60)	2.65* (1.34–5.22)	1.95* (1.15–3.31)	2.17* (1.62–2.91)
Sprint run	2.15* (1.22–3.78)	2.78* (1.75–4.43)	2.95* (1.80–4.83)	2.50* (1.75–3.57)
Vertical jump	1.53 (0.82–2.83)	2.50* (1.59–3.93)	1.97* (1.33–2.91)	1.78* (1.30–2.43)
Side gallop	1.48 (0.81–2.72)	1.44* (1.06–1.96)	1.84* (1.00–3.37)	1.62* (1.08–2.43)
Leap	2.21* (1.13–4.35)	1.86 (0.93–3.72)	1.85 (0.83–4.14)	1.35* (1.03–1.78)

[a] Comparisons are within each school grade and are between: not adequately fit versus adequate fitness, does not meet physical activity recommendation versus meets physical activity recommendation, and not overweight/obese versus overweight/obese. n, statistical significance could not be calculated because of small numbers.

[b] Cardiorespiratory fitness not tested in Grade 2 students.

* $P < .05$. —, not tested.

TABLE 3 Health-related Factors Associated With Low Competency in FMS Among Girls[a]

Girls	Grade 2	Grade 4	Grade 6	High School
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Unfit versus adequately fit[b]				
Object-control skills; low competency (≤2/3 skills)	—	n	1.92* (1.02–3.63)	2.60* (1.69–3.03)
Over-arm throw	—	n	2.17* (1.11–4.24)	2.34* (1.55–3.55)
Kick	—	n	2.22* (1.27–3.87)	2.48* (1.76–3.50)
Catch	—	8.51* (1.46–49.73)	1.46* (0.85–2.50)	2.28* (1.56–3.35)
Locomotor skills; low competency (≤3/4 skills)		7.92 (0.83–75.51)	5.87* (3.51–9.82)	3.01* (2.31–3.94)
Sprint run	—	15.15* (1.53–150.24)	3.01* (1.87–4.87)	2.69* (1.86–3.88)
Vertical jump	—	9.51 (0.94–96.46)	3.34* (2.08–5.37)	2.82* (1.93–4.12)
Side gallop	—	10.7* (1.80–63.79)	2.52* (1.32–4.81)	3.50* (1.88–6.51)
Leap	—	3.87 (0.48–31.37)	2.45* (1.18–5.08)	2.08* (1.51–2.87)
Does not meet physical activity recommendation versus meets recommendation				
Object-control skills; low competency (≤2/3 skills)	3.28 (0.89–12.08)	1.27 (0.69–2.37)	1.34 (0.80–2.24)	1.68* (1.24–2.27)
Over-arm throw	0.87 (0.40–1.91)	1.38 (0.84–2.28)	1.29 (0.73–2.28)	1.77* (1.27–2.48)
Kick	n	n	2.22* (1.27–3.87)	2.48* (1.76–3.50)
Catch	1.15 (0.69–1.93)	1.63* (1.19–2.21)	1.45 (0.94–2.24)	1.40 (0.96–2.06)
Locomotor skills; low competency (≤3/4 skills)	1.36 (0.79–2.32)	1.82* (1.27–2.63)	1.61* (1.03–2.51)	1.69* (1.24–2.31)
Sprint run	1.96* (1.22–3.14)	1.14 (0.84–1.55)	2.04* (1.33–3.12)	1.66* (1.22–2.26)
Vertical jump	0.99 (0.66–1.49)	2.14* (1.44–3.17)	1.25 (0.78–1.99)	1.48* (1.06–2.07)
Side gallop	1.28 (0.89–1.84)	1.05 (0.70–1.57)	1.31 (0.71–2.43)	1.17 (0.71–1.94)
Leap	1.03 (0.67–1.57)	1.46* (1.00–2.13)	1.82* (1.08–3.07)	1.87* (1.41–2.50)
Overweight or obese versus not overweight/obese				
Object-control skills; low competency (≤2/3 skills)	0.60 (0.13–2.85)	1.77 (0.78–4.00)	1.42 (0.83–2.44)	1.19 (0.79–179)
Over-arm throw	1.37 (0.54–3.46)	1.32 (0.68–2.58)	1.33 (0.76–2.35)	1.45 (0.97–2.17)
Kick	0.64 (0.19–2.12)	2.58* (1.12–5.94)	3.38* (1.76–6.49)	1.04 (0.75–1.44)
Catch	0.71 (0.48–1.04)	1.20 (0.79–1.82)	1.20 (0.86–1.67)	1.21 (0.75–1.97)
Locomotor skills; low competency (≤3/4 skills)	1.42 (0.75–2.71)	2.83* (1.56–5.14)	3.60* (2.19–5.93)	1.55* (1.08–2.21)
Sprint run	1.27 (0.74–2.20)	2.70* (1.67–4.38)	2.96* (1.88–4.67)	1.56* (1.11–2.19)
Vertical jump	1.02 (0.68–1.52)	2.96* (1.94–4.54)	3.30* (2.05–5.32)	1.82* (1.34–2.46)
Side gallop	0.89 (0.60–1.33)	2.30* (1.56–3.38)	2.07* (1.37–3.13)	1.24 (0.72–2.14)
Leap	3.06* (1.45–6.47)	1.89* (1.28–2.79)	2.45* (1.44–4.17)	1.68* (1.17–2.43)

[a] Comparisons are within each school grade and are between: not adequately fit versus adequate fitness, does not meet physical activity recommendation versus meets physical activity recommendation, and not overweight/obese versus overweight/obese. n, statistical significance could not be calculated because of small numbers.

[b] Cardiorespiratory fitness not tested in Grade 2 students.

* $P < .05$. —, not tested.

Although there were no consistent associations between low competency in object-control skills and students who were overweight/obese, there was a pattern of low competency for the over-arm throw and kick among overweight/obese boys in Grade 4 and high school. For locomotor skills, there was a strong association between low competency and students who were overweight/obese, and these associations were consistent for most of the individual locomotor skills.

The odds of low competency in object-control and locomotor skills among boys and girls are shown in Tables 4 and 5, respectively, by sociodemographic characteristics. There were no consistent associations between low competency and students' locality, although urban high school girls were 84% more likely to be less skilled in locomotor skills. Similarly, there were no consistent associations between boys' SES background and low competency in FMS. Low SES Grade 2 boys were twice as likely to have low competency in object-control skills and low SES high school boys were 35% more likely to demonstrate low competency in locomotor skills, compared with high SES peers. Compared with high SES girls, low SES high school girls were 54% more likely to demonstrate low competency in locomotor skills, whereas elementary school girls from low SES were twice as likely to have low competency in the vertical jump.

Boys from non–English-speaking cultural backgrounds in Grades 4, 6, and high school were more likely to have low competency in object-control skills (OR 3.05, 95% confidence interval [CI] 1.65–5.64; OR 1.89, 95% CI 1.02–3.24; and OR 1.87, 95% CI 1.05–3.12, respectively) compared with English-speaking peers. Specifically, non–English-speaking boys consistently demonstrated low competency in the kick and in the vertical jump. Conversely, among girls, there were no consistent associations between low competency in FMS and cultural background; however, there was some evidence that Grades 4 and 6 girls from non–English-speaking backgrounds had low competency in the leap.

TABLE 4 Sociodemographic Characteristics and BMI Category Associated With Low Competency in FMS Among Boys[a]

Boys	Grade 2	Grade 4	Grade 6	High School
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Location (rural versus urban)				
Object-control skills; low competency (≤2/3 skills)	0.89 (0.35–2.29)	0.90 (0.59–1.38)	1.00 (0.38–2.61)	0.73 (0.45–1.20)
Over-arm throw	0.52* (0.28–0.97)	0.44* (0.24–0.81)	0.69 (0.40–1.20)	0.82 (0.54–1.24)
Kick	0.85 (0.48–1.51)	0.76 (0.55–1.06)	0.62 (0.22–1.77)	0.97 (0.63–1.48)
Catch	1.48 (0.70–3.16)	0.87 (0.55–1.38)	1.42 (0.70–2.90)	0.82 (0.46–1.48)
Locomotor skills; low competency (≤3/4 skills)	0.61 (0.32–1.19)	0.94 (0.53–1.67)	1.15 (0.44–3.04)	1.18 (0.83–1.67)
Sprint run	1.13 (0.61–2.10)	0.66* (0.43–1.00)	0.62 (0.35–1.11)	0.96 (0.73–1.28)
Vertical jump	0.56 (0.20–1.54)	1.03 (0.69–1.53)	1.26 (0.69–2.31)	1.03 (0.67–1.58)
Side gallop	1.02 (0.56–1.85)	1.04 (0.64–1.70)	0.63 (0.29–1.37)	0.63 (0.35–1.10)
Leap	0.95 (0.45–2.00)	1.77 (0.87–3.57)	1.35 (0.53–3.43)	1.25 (0.76–2.07)
SES (low versus high)				
Object-control skills; low competency (≤2/3 skills)	2.05* (1.12–3.64)	1.56 (0.97–2.49)	0.94 (0.57–1.54)	1.38 (0.92–2.09)
Over-arm throw	1.60 (0.85–3.03)	2.50* (1.65–3.80)	1.49 (0.81–2.73)	0.77 (0.50–1.21)
Kick	1.45 (0.71–2.97)	2.41* (1.40–4.17)	1.16 (0.54–2.49)	1.12 (0.74–1.69)
Catch	1.31 (0.78–2.22)	1.50 (0.98–2.28)	1.90 (0.94–3.87)	0.72 (0.41–1.27)
Locomotor skills; low competency (≤3/4 skills)	1.19 (0.59–2.39)	1.49 (0.93–2.39)	0.81 (0.50–1.32)	1.35* (1.02–1.78)
Sprint run	1.88 (0.84–4.21)	1.22 (0.75–1.99)	0.92 (0.49–1.72)	1.14 (0.82–1.59)
Vertical jump	1.17 (0.54–2.52)	1.53 (0.87–2.68)	1.50 (0.88–2.56)	0.98 (0.65–1.49)
Side gallop	1.79* (1.07–2.98)	1.40 (0.84–2.33)	1.41 (0.74–2.68)	0.45* (0.25–0.79)
Leap	1.04 (0.32–3.37)	2.94* (1.19–7.24)	1.72 (0.72–4.09)	0.96 (0.66–1.41)
Non–English speaking versus English speaking				
Object-control skills; low competency (≤2/3 skills)	1.95 (0.86–4.41)	3.05* (1.65–5.64)	1.82* (1.02–3.24)	1.87* (1.05–3.12)
Over-arm throw	1.32 (0.76–2.29)	1.52 (0.93–2.47)	1.27 (0.67–2.42)	1.40 (0.87–2.23)
Kick	1.70 (0.84–3.45)	2.19* (1.26–3.81)	2.28* (1.19–4.36)	1.70* (1.06–2.72)
Catch	2.42* (1.51–3.88)	2.16* (1.44–3.25)	1.07 (0.61–1.89)	0.80 (0.48–1.31)
Locomotor skills; low competency (≤3/4 skills)	3.96* (1.04–15.13)	1.87 (0.98–3.56)	1.76 (0.94–3.31)	0.86 (0.61–1.22)
Sprint run	0.96 (0.56–1.67)	1.50 (0.90–2.50)	1.61* (1.01–2.55)	1.12 (0.80–1.58)
Vertical jump	1.53 (0.82–2.83)	2.50* (1.59–3.93)	1.97* (1.33–2.91)	1.78* (1.30–2.43)
Side gallop	1.08 (0.56–2.07)	1.37 (0.91–2.07)	1.35 (0.79–2.31)	0.78 (0.49–1.27)
Leap	2.21* (1.13–4.35)	1.86 (0.93–3.72)	1.85 (0.83–4.14)	0.97 (0.73–1.30)

[a] Comparisons are within each school grade or level and are between rural versus urban locality, low versus high SES tertile, and non–English speaking versus English speaking.
* $P < .05$.

DISCUSSION

To our knowledge, Australia is the only country to undertake regular population monitoring of children's FMS. Although it is not known if our findings are generalizable to children in other countries, as BMI and physical activity levels are similar across developed countries we would not expect there to be a great difference. We showed that low competency in FMS among school students was associated with poorer health outcomes, including low cardiorespiratory fitness, low physical activity, and being overweight or obese. Furthermore, we showed that low competency in FMS was associated with a range of sociodemographic characteristics, including gender, SES, and cultural background. The findings are useful to guide policy on where best to invest resources to improve FMS among youth.

Developmentally, children should demonstrate mastery of most FMS by Grade 2,[1] yet the findings presented here clearly show a high prevalence of low competency in FMS in Grade 2 with almost 90% of students not demonstrating mastery of all 4 locomotor skills. Although the prevalence of low competency in FMS declined across grade groups, most high school students had not mastered basic locomotor skills and girls had not mastered object-control skills. There were large age-related improvements in boys' object-control skills; however, the gender difference is less likely to be attributable to biological difference because skills were assessed by using qualitative- (process), rather than quantitative- (product), orientated criteria.

Gender differences in FMS reported here are consistent with other research that shows boys are more likely to master object-control skills, as these skills are required for ball sports commonly played by boys. Similarly, girls are more likely to master locomotor skills, as these skills are required for activities such as dancing and gymnastics, which are more common among girls.[7] Thus, the observed gender difference in skills may be attributable to gender norms that preference children's activities,[23] or that girls are not exposed or provided with reinforcing opportunities to develop object-control skills.

Cardiorespiratory endurance, or aerobic fitness, is an outcome of sustained

TABLE 5 Characteristics and BMI Category Associated With Low Competency in FMS Among Girls[a]

Girls	Grade 2	Grade 4	Grade 6	High School
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Locality (rural versus urban)				
Object-control skills; low competency (≤2/3 skills)	n	1.04 (0.59–1.82)	0.92 (0.50–1.70)	0.83 (0.56–1.25)
Over-arm throw	1.62 (0.41–6.39)	1.54 (0.71–3.34)	0.78 (0.43–1.41)	0.90 (0.54–1.51)
Kick	n	1.01 (0.46–2.24)	0.84 (0.48–1.47)	1.32 (0.93–1.87)
Catch	1.54 (0.81–2.92)	1.39 (0.76–2.53)	2.12 (0.98–4.60)	0.93 (0.48–1.80)
Locomotor skills; low competency (≤3/4 skills)	0.85 (0.41–1.77)	1.00 (0.36–2.77)	0.50 (0.21–1.19)	1.84* (1.14–2.97)
Sprint run	0.94 (0.47–1.88)	1.21 (0.60–2.46)	0.47 (0.18–1.21)	1.86* (1.28–2.70)
Vertical jump	0.64 (0.33–1.24)	1.33 (0.46–3.86)	0.99 (0.49–2.00)	1.70 (0.99–2.89)
Side gallop	1.39 (0.63–3.05)	1.36 (0.71–2.63)	1.24 (0.23–6.65)	1.14 (0.55–2.40)
Leap	1.23 (0.48–3.16)	0.66 (0.33–1.32)	0.43* (0.25–0.74)	1.45 (0.84–2.50)
SES (low versus high)				
Object-control skills; low competency (≤2/3 skills)	1.37 (0.34–5.46)	0.80 (0.36–1.78)	1.06 (0.67–1.68)	1.07 (0.71–1.63)
Over-arm throw	1.62 (0.75–3.49)	2.25 (0.85–5.96)	1.37 (0.84–2.23)	0.83 (0.51–1.36)
Kick	1.27 (0.32–5.10)	2.29 (0.76–6.95)	1.78 (0.95–3.35)	1.30 (0.80–2.11)
Catch	1.36 (0.86–2.16)	2.17* (1.32–3.55)	2.19* (1.19–4.04)	0.96 (0.56–1.65)
Locomotor skills; low competency (≤3/4 skills)	1.47 (0.84–2.58)	1.35 (0.74–2.46)	1.29 (0.74–2.27)	1.54* (1.07–2.23)
Sprint run	1.13 (0.59–2.15)	1.70 (0.92–3.13)	1.35 (0.65–2.81)	1.71* (1.08–2.70)
Vertical jump	2.61* (1.15–5.90)	2.26* (1.15–4.47)	2.00* (1.09–3.67)	2.07* (1.38–3.11)
Side gallop	1.94* (1.11–3.38)	1.16 (0.67–2.01)	1.94* (1.07–3.54)	1.20 (0.60–2.37)
Leap	1.70 (0.80–3.59)	2.22* (1.12–4.40)	1.94 (0.93–4.03)	1.68* (1.04–2.72)
Non–English-speaking versus English speaking				
Low competency in object-control skills (≤1/3 skills)	2.30 (0.27–19.46)	0.83 (0.29–2.34)	0.81 (0.47–1.43)	1.19 (0.81–1.74)
Over-arm throw	0.89 (0.34–2.34)	0.78 (0.36–1.71)	1.07 (0.64–1.78)	1.10 (0.65–1.88)
Kick	1.67 (0.43–6.43)	2.48 (0.94–6.53)	0.84 (0.45–1.59)	1.54 (0.99–2.4)
Catch	1.29 (0.68–2.44)	1.86* (1.23–2.81)	1.12 (0.61–2.05)	0.97 (0.57–1.65)
Locomotor skills; low competency (≤3/4 skills)	1.76 (0.96–3.22)	1.29 (0.67–2.49)	2.25* (1.08–4.70)	1.17 (0.82–1.68)
Sprint run	1.37 (0.91–2.06)	1.23 (0.72–2.10)	0.84 (0.45–1.57)	1.15 (0.69–1.90)
Vertical jump	2.58* (1.41–4.73)	1.38 (0.79–2.42)	1.92 (0.82–4.49)	1.31 (0.98–1.74)
Side gallop	0.99 (0.68–1.46)	1.42* (1.01–2.00)	1.59 (0.86–2.94)	1.16 (0.63–2.15)
Leap	1.39 (0.66–2.95)	1.65* (1.04–2.61)	2.64* (1.54–4.52)	1.29 (0.85–1.97)

n, statistical significance could not be calculated because of small numbers.

[a] Comparisons are within each school grade or level and are between rural versus urban locality, low versus high SES tertile, and non–English speaking versus English speaking.

* $P < .05$.

moderate-to-vigorous physical activity and an important component of metabolic health.[24,25] The strong consistent association observed between low competency in individual and collective FMS and inadequate cardiorespiratory fitness and failure to meet the physical activity recommendation among school students is of concern. This finding is not novel, with other studies reporting similar findings[2,26–28]; however, this study suggests that the effect of low competency in FMS on poor fitness levels was slightly stronger among boys. Boys with low competency in object-control skills and girls with low competency in locomotor skills were twice as likely to not meet physical activity guidelines. For Grades 2 and 4 students this finding should be interpreted with caution, as their physical activity questions have not been validated. Given that boys were more likely to demonstrate mastery of object-control and girls locomotor skills, this finding suggests children need to be skilled in both locomotor and object-control skills to meet physical activity recommendations.

Overweight and obese children consistently showed higher levels of low competency in locomotor skills, which is consistent with earlier studies.[29–31] Biomechanical factors associated with high body mass, such as lower limb problems,[32,33] have shown that overweight and obese children have greater difficulty in performing locomotor skills. Similarly, there was some evidence that overweight/obese boys demonstrated low competency in object-control skills associated with sports that typically require greater locomotion to perform, such as the kick and over-arm throw.

Although there were no rural-urban differences in students' low competency in FMS, SES and cultural background were associated with low competency in FMS but there were different gender patterns. In contrast to boys, there was some evidence of SES disparities among girls across the suite of locomotor skills, which may indicate that sports and activities that require locomotor skills (such as dance and gymnastics) are less prevalent, or less accessible, to girls from low SES backgrounds. Interestingly, cultural background was strongly associated with low competency among boys,

but not girls. Boys from non–English-speaking backgrounds, specifically those from Middle Eastern and Asian cultural backgrounds, were twice as likely to show low competency in the kick and vertical jump. This finding may potentially be because of the higher prevalence of overweight and obesity among the Middle Eastern students (31%) and the lower prevalence of Middle Eastern and Asian students meeting physical activity recommendations in this study.[10]

The strengths of this study were the large, representative sample of schoolchildren and the use of objective measures of FMS, cardiorespiratory fitness, and BMI. Further, FMS were assessed by using process-orientated criteria to assess the technique in performing components of a skill. That is, the assessment is "how a student throws a ball," not "how far the student throws the ball." A limitation, however, of the FMS assessment is that it assumes all components have equal value, and skills with fewer components are, mathematically, easier to master. Although longitudinal studies are required to determine causal relationships, multiple cross-sectional studies have shown an association between low competency of FMS and fitness, physical activity, and overweight/obesity, which suggests that these relationships could be bidirectional. Demographic factors are nondirectional characteristics and highlight that students from low SES and non–English-speaking cultural backgrounds would benefit from targeted programs to improve their FMS to assist them to participate in health-enhancing physical activities.

Motor skill interventions are an effective strategy to improve FMS competence in children,[34,35] so it is therefore important that the findings reported here are translated into practice. For example, in NSW, earlier evidence on low competency in FMS among school-aged children[36,37] has been used to develop specific teaching resources,[6,38] professional development programs on FMS for early childhood professionals,[39] and testing the feasibility of a school-based FMS program in schools with culturally diverse populations (A.D.O., L. L.H., P. Pearson, EdD, K. McKeen, MEd, unpublished observations). Potentially, of greatest importance is for parents of young children to provide their child with opportunities to practice FMS, through active play and games either directly (ie, playing with the child) or indirectly, by encouraging outdoor play to establish motor skill development.

CONCLUSIONS

Low competency in FMS among school-aged children was strongly associated with lower cardiorespiratory fitness and physical activity levels. The characteristics of low competency in FMS differ for boys and girls, and the findings indicate that FMS programs need to more intensively target girls from low SES backgrounds and boys from non–English-speaking cultural backgrounds. Further, the high prevalence of low competency in Grade 4 students indicates that FMS interventions need to start during preschool years.

ACKNOWLEDGMENTS

Ms Reinten-Reynolds was employed by the NSW Ministry of Health on the NSW Biostatistical Officer Training Program at the time this work was undertaken. The authors are grateful for the support and cooperation of the government, Catholic, and independent education systems and for the cooperation of the participating schools and students.

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Prevalence and Correlates of Low Fundamental Movement Skill Competency in Children

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Pediatrics; originally published online July 23, 2012;
DOI: 10.1542/peds.2012-0345