Original article

Social-ecological correlates of fundamental movement skills in young children

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Abstract

Purpose: To identify the social-ecological correlates associated with fundamental movement skills at the child, family, and environment levels in young children.

Methods: Preschool children from 4 Colorado Head Start/preschool centers were recruited from 2010 to 2012. Two hundred twenty-eight children (128 girls; age $= 56.08 \pm 4.09$ months; body mass index (BMI) z-score $= 0.53 \pm 1.12$ (mean $\pm$ SD); 42.1% Hispanic/Latino) and 159 families were included in the final analysis. Children's perceived competence and fundamental movement skills were assessed via the Pictorial Scale of Perceived Competence and Social Acceptance and the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition. Data on the number of children in the family, parent age, BMI, education, employment status, family income, perception of child coordination, and home physical activity environment were collected via a questionnaire. Linear regressions adjusted for child BMI, age, sex, and school site were performed at each level.

Results: Child perceived cognitive competence was positively associated with locomotor skills ($p = 0.04$; adjusted $R^2 = 0.035$) and object-control skills ($p = 0.003$; adjusted $R^2 = 0.083$) at the child level. Parent education, BMI, and perception of child coordination were positively associated with locomotor skills and explained 8.8% of variance, but only parent education was significant ($p = 0.04$) at the family level. In addition, physical environment was positively associated with locomotor skills ($p = 0.02$) and explained 5.5% of variance at the environment level.

Conclusion: Social-ecological correlates associated with young children's fundamental movement skills are multidimensional and differ according to skill category at the child, family, and environment levels.

1. Introduction

Fundamental movement skills (FMS) are building blocks that lead to specialized movement sequences and sport skills that are required for adequate participation in physical activity (PA) for children, adolescents, and adults.[1] FMS commonly develops in childhood and hones subsequently into sport- and context-specific skills, including locomotor (e.g., running, hopping, leaping, jumping), object control or manipulative (e.g., throwing, catching, kicking, striking), and stability or balance (e.g., rolling, landing, bending, stretching) skills.[1] It has also been suggested that strength is an important component in a comprehensive measure of motor skills because it is an essential component of gross motor performance in many daily activities.[2,3] Therefore, strength is critical for successful FMS development and performance. Although children's fundamental movement patterns may develop naturally, the higher levels of FMS proficiency are more likely to be achieved with appropriate practice, encouragement, feedback, and instructions.[4] If children receive inadequate motor skill instructions and practice during early childhood, they may demonstrate developmental delays in their motor competence.[5] Given its importance, the development of FMS is a key component of early childhood education programs. Although the mastery of FMS has been considered a significant contributor to children's physical, social, and cognitive development and has been suggested as an important component in laying a solid foundation for an active lifestyle,[6] only 50% of children have been shown to demonstrate

competency in a broad range of motor skills.[7] Because early childhood has been marked as one of the most critical and intensive periods in the establishment of fundamental movement patterns, understanding the correlates that are associated with young children's motor development is important.

Emerging evidence supports the relationships between FMS and a range of health outcomes in children, including positive correlations between FMS and PA levels and cardiorespiratory fitness, and an inverse association with weight status.[8] Moreover, review evidence has confirmed a positive association between FMS and PA participation[9] and fitness[10] in children and adolescents. In the most recent review, Barnett et al.[11] suggested that although age, sex, and socioeconomic background are potential correlates of children's FMS, few studies have investigated the cognitive, psychosocial, cultural, or physical environment correlates associated with FMS. Notably, Bellows et al.[12] used a social-ecological model as a guide to understanding healthy growth in young children. In the proposed model, the authors conceptualized child development from an interactive contextual perspective and emphasized that multidimensional correlates and contextual characteristics were associated with PA and motor behaviors, including child characteristics (i.e., sex, ethnicity, age, anthropometry, and perceived competence), family factors (i.e., parent characteristics, socioeconomic status, siblings, and parents' perception of their child's PA and motor skills), and home environment (i.e., availability of PA equipment/play spaces in the home) (Fig. 1).

Indeed, previous studies have examined the association between FMS and social-ecological correlates in preschool children. For example, Cools et al.[13] observed that a father's PA level and the frequency with which parents bought new equipment for their child were positively related to the child's motor skills. Barnett et al.[14] found that a child's age, frequency of moderate-to-vigorous PA, and attendance level at dance classes were related to a child's motor skills. Moreover, Playford et al.[15] indicated that socioeconomic status was only

associated with preschool children's fine motor skills and not with their gross motor skills. Although the influences on young children's FMS are multidimensional[16] and the preceding studies have attempted to investigate the relationship between FMS and some contextual characteristics, many potential correlates that might be related to FMS remain unexplored. Therefore, the purpose of the study was to determine the social-ecological correlates of FMS in preschool-age children. Specifically, we aimed to identify the child, family, and environment correlates that were associated with balance, locomotor skills, object control skills, and strength in this population.

2. Methods

2.1. Research design and participants

This study reports on the baseline results of the Colorado Longitudinal Eating And Physical activity (LEAP) study, which examined whether the positive effects of a previous nutrition and FMS preschool intervention were sustained through early elementary school at 2 years of follow-up. The complete study design of the Colorado LEAP study has been described elsewhere.[12]

A total of 257 parent−child dyads were recruited across 3 cohorts from 4 Colorado Head Start/preschool centers at baseline assessment from 2010 to 2012. Children were excluded from the study if (1) they were diagnosed with developmental disabilities such as cerebral palsy and Down syndrome, (2) they were not expected to enter kindergarten the following school year, or (3) the child's parents did not provide consent forms and the child did not assent to participate in the study.

2.2. Procedures

After the preschool/Head Start center directors agreed in writing to participate in the project, parents and guardians received study information during parent workshops scheduled in the evenings at preschool centers or via packets sent to the child's home. Packets were available in English and Spanish, and Spanish-speaking study staff members were available for families requiring interpretation or assistance. Parents and guardians provided written consent for their child to participate in the study. All child outcomes were assessed in the preschool/childcare setting after children provide verbal assent. Parent packets, including questionnaire instruments related to family and environment correlates, were sent to the child's home and returned via the child's backpack. A monetary incentive of USD40 was given to parents after evaluation packets were returned. This study adhered to the ethical guidelines for human research and was granted approval by the Institutional Review Board at Colorado State University.

2.3. Measurements

2.3.1. Demographic and anthropometric characteristics

A questionnaire was used to collect data on participating children and parents. For children, the following data were collected: date of birth, sex, race/ethnicity, and disability status. For parents, the collected data included age, height and weight, race/ethnicity,
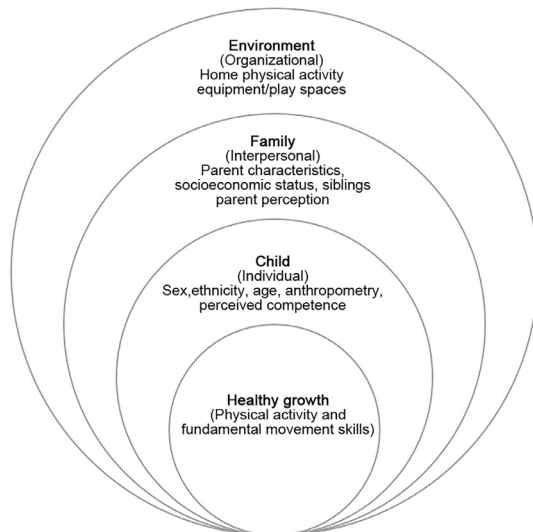

Fig. 1. Social-ecological model for physical activity and fundamental movement skill correlates for the Colorado Longitudinal Eating And Physical activity (LEAP) study.[12]

number of children in the family, parents' highest level of education, employment status, and annual household income and were reported via a questionnaire completed by either the mother or the father. Data on children's height and weight were also collected. Children's height without shoes was measured to the nearest 0.1 cm using a portable stadiometer (Seca 213; Seca GmbH & Co. KG., Hamburg, Germany), and weight was assessed via a digital scale (Lifesource ProFit UC321; Milpitas, CA, USA) after voiding and wearing light clothing and no shoes. Body mass index (BMI) was calculated using weight (in kilograms)/height (in meters squared) for parents. For children, sex- and age-adjusted BMI z-scores were calculated children using the 2000 Centers for Disease Control and Prevention Growth Charts for the United States.[17]

2.3.2. Perception of child coordination

Child motor coordination as perceived by the parent was assessed by asking "How do you rate your child's athletic coordination, compared to others of the same age and sex? Response options on a 5-point Likert-type scale included 1 (*much less coordinated*), 2 (*somewhat less coordinated*), 3 (*about the same*), 4 (*somewhat more coordinated*), and 5 (*much more coordinated*).

2.3.3. Home PA environment

Parents responded to a 16-item validated activity environment survey[18] that listed various PA equipment/play spaces that children and/or adults might use at home. Relatively high inter rater reliability (i.e., 67%−99%) was seen between researchers and parents using the activity environment survey.[18] Parents responded with *yes* or *no* to the availability of each item. Examples of items include a basketball hoop, swing set, trampoline, hula loop, outdoor equipment, and recreation room. All items were summed to determine a total availability score for the home PA environment (possible range 16−32). This assessment required 4−6 min to administer per parent.

2.3.4. Perceived competence

Children's perceived competence was measured via the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children,[19] a valid and reliable measure for assessing young children's self-perceptions. Previous research has shown that the Pictorial Scale of Perceived Competence and Social Acceptance has strong psychometric properties for children 4 years of age and older (e.g., $\alpha > 0.70$), with an inter rater reliability ranging from 75% to 89%.[19] The Pictorial Scale of Perceived Competence and Social Acceptance assesses 4 domains of perceived competence and acceptance, including physical competence, cognitive competence, maternal acceptance, and peer acceptance. All 4 domains were assessed, but we used only physical competence and cognitive competence domains in the current analysis. Specifically, children responded to 6 items for each construct using a 4-point Likert-type scale ranging from 1 (*not too good*) to 4 (*really good*). Scale means were calculated to determine the children's perceived self-competence in the physical and cognitive domains. These 2 assessments required 6−8 min to administer per child.

2.3.5. FMS

Children's motor skills were assessed via the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2), which is a standardized, norm-referenced measure of motor proficiency for children 4−21 years old.[2] We administered 4 of the 6 subtests, namely, (1) balance, (2) running speed and agility (locomotor skills), (3) upper limb coordination (object control skills), and (4) strength to interpret the children's motor competence. High inter rater reliability (i.e., 95%−99%) was observed for each of the subtests using Pearson product-moment correlations.[20] The test required 25−35 min per child to administer. Raw scores on the different items were converted into standard scores to interpret norm-referenced test performance.

2.4. Data analysis

First, data were examined for missing values, significant outliers, and the normality of distributions, skewness, and kurtosis. Thereafter, outliers were adjusted to lessen the impact of extreme scores.[21] Second, descriptive statistics (mean, SD, and frequencies) were calculated for all variables. Third, an independent t test was conducted to assess differences in primary variables by sex at the child level. Cohen's effect sizes (d) were computed using the formula $d =$ mean difference/SD of the difference in scores, with an effect size of 0.2 considered small, 0.5 classified as medium, and 0.8 categorized as large.[22] Fourth, bivariate correlations were determined using Pearson's correlation coefficients (r) between all predictors and dependent variables. According to Cohen,[22] the effect size is low if the r varies around 0.1, medium if the r varies around 0.3, and large if the r varies by >0.5. The child-level predictors included the child's perceived cognitive and physical competence. The family-level predictors were number of children in family, parent age, BMI, education, employment status, family income, and perception of the child's coordination. The environment-level predictor included the home PA environment. Dependent variables were balance, locomotor skills, object control skills, and strength. Only participants with complete information on the predictors and dependent variables were included in the analysis. Finally, linear multiple regressions, with balance, locomotor skills, object control skills, and strength as dependent variables and correlates at each child, family, and environment levels that were significantly correlated with each dependent variable, were performed separately. Because child BMI, age, and sex are potential confounding variables that may affect the accuracy of regression analysis, they were considered covariates. In addition, school site was also included as a covariate given the differences in school environments and in the length of the school day at the various schools. Therefore, all models adjusted for child age, sex, BMI z-score, and school site. The residuals were normally distributed in all models. SPSS (Version 25.0; IBM Corp., Armonk, NY, USA) was used to perform the analysis using $p < 0.05$ set for statistical significance.

3. Results

Of 257 parent−child dyads, 249 children completed on-site measures (perceived competence and FMS testing) and 178 parents returned the questionnaires (response rate of 69%). A total of 5 cases were identified as outliers (3 on balance and 2 on locomotor skills) at the child level owing to inappropriate scale (i.e., very small or very large) and/or errors on data entry. No outliers were verified at the family or environment levels. After removing the outliers and missing values, 228 children (128 girls; age = 56.08 ± 4.09 months, BMI z-score = 0.53 ± 1.12; 42.1% Hispanic/Latino) had complete perceived competence and FMS scores, and 159 families had complete family and home PA environment questionnaire data and were included for the final analysis. The nonresponder analysis did not show significant differences in the study variables of parents who returned the questionnaires versus parents who did not. Therefore, linear regressions were performed with 228 children at the child level and 159 parents at the family and environment levels. Complete baseline measures are presented in Table 1.

Among parents, 57.2% were aged 30−49 years, 47.8% were overweight or obese, 89.9% had some college and/or post high school equivalent degree, 67.9% were employed either full or part time, and 69.4% were considered low income, defined as 185% of the U.S. federal poverty level.[23] The number of children in the families varied, with most families having 2−3 children (72.9%). In addition, nearly one-half of the parents (47.2%) perceived their child to be somewhat less coordinated than their peers (and the parents had an average score of 21.64 ± 2.78) on the home PA equipment/play spaces questionnaire. Complete baseline measures are presented in Table 2. Significant sex differences in children's FMS were observed, with boys demonstrating better object control skills ($t = 3.39$, $p < 0.01$, Cohen's $d = 0.43$), whereas girls demonstrated better locomotor skills ($t = -2.07$, $p < 0.05$, Cohen's $d = 0.28$) and balance ($t = -2.02$, $p < 0.05$, Cohen's $d = 0.27$) (Table 1).

Of child correlates, bivariate correlations indicated that child-perceived cognitive competence was positively associated with locomotor skills ($r = 0.14$, $p < 0.05$) and object control skills ($r = 0.17$, $p < 0.05$). In addition, 3 family correlates—parent education ($r = 0.18$, $p < 0.05$), parent BMI ($r = -0.23$, $p < 0.01$), and perceptions of child coordination ($r = 0.19$, $p < 0.05$)—were related to locomotor skills, and parent BMI was negatively associated with strength ($r = -0.17$, $p < 0.05$). Likewise, physical environment was positively correlated with children's locomotor skills ($r = 0.20$, $p < 0.05$) and strength ($r = 0.18$, $p < 0.05$). Notably, none of child, parent, or environment correlates were associated with children's balance (Table 3). After adjusting for child age, sex, BMI z-score, and school site, the subsequent regressions showed that child-perceived cognitive competence was a significant predictor for locomotor skills ($F(1, 227) = 2.64$, $p = 0.024$, adjusted $R^2 = 0.035$; $\beta = 0.14$, $p = 0.04$) and for object control skills ($F(1, 227) = 3.92$, $p = 0.001$, adjusted $R^2 = 0.083$; $\beta = 0.19$, $p = 0.003$) at the child level. In addition, parent education, BMI, and perception of child coordination explained 8.8% of child's locomotor skills, but only parent education remained significant at the family level ($F(1, 158) = 3.17$, $p = 0.004$, adjusted $R^2 = 0.088$; $\beta = 0.16$, $p = 0.04$). Last, physical environment explained 5.5% of the variance and was a significant predictor of locomotor skills ($p = 0.02$) at the environment level ($F(1, 158) = 2.83$, $p = 0.018$, adjusted $R^2 = 0.055$; $\beta = 0.19$, $p = 0.02$) (Table 4).

4. Discussion

Preschool-aged children are an important target for behavioral change strategies because this age cohort may enhance tracking into the crucial period of adolescence. FMS is a crucial contributor to a healthy lifestyle in early childhood and therefore is considered a vital part of child development. Driven by the social-ecological model (Fig. 1),[10] the current

Table 1
Colorado LEAP study child characteristics at baseline ($n = 228$).

Variable	Boys ($n = 100$)	Girls ($n = 128$)	All	Cohen' d
Age (month)	56.15 ± 4.19	56.02 ± 4.02	56.08 ± 4.09	
BMI	16.59 ± 2.47	16.41 ± 2.23	16.48 ± 2.34	
BMI (z-score)	0.56 ± 1.17	0.53 ± 1.07	0.53 ± 1.12	
Race				
White	77 (43%)	100 (57%)	177 (77.6%)	
Other	23 (45%)	28 (55%)	51 (22.4%)	
Ethnicity				
Hispanic/Latino	41 (42.7%)	55 (57.3%)	96 (42.1%)	
Cognitive competence	3.33 ± 0.49	3.38 ± 0.43	3.35 ± 0.45	
Physical competence	3.08 ± 0.55	3.15 ± 0.55	3.12 ± 0.55	
Balance	13.05 ± 3.76	14.10 ± 3.99*	13.64 ± 3.92	0.27
Running speed and agility (locomotor)	14.03 ± 3.82	15.14 ± 4.13*	14.65 ± 4.03	0.28
Upper limb coordination (object control)	14.09 ± 4.39**	12.12 ± 4.31	12.98 ± 4.45	0.43
Strength	16.15 ± 3.91	16.39 ± 3.38	16.29 ± 3.62	

Notes: Cohen's d was only reported when there was statistical significance. Data are presented as mean ± SD or number (%).
* $p < 0.05$, ** $p < 0.01$, significant sex difference.
Abbreviations: BMI = body mass index; LEAP = Longitudinal Eating And Physical activity.

Table 2
Colorado LEAP study family and environment characteristics at baseline ($n = 159$).

Variable	n	%
Family correlates		
Number of children in family		
1	21	13.2
2	67	42.1
3	49	30.8
>4	22	13.9
Parent age (years)		
18−29	64	40.2
30−49	91	57.2
50−64	4	2.6
Parent BMI		
Normal weight	83	52.2
Overweight	44	27.7
Obese	32	20.1
Parent education		
Less than high school education	16	10.1
High school education	43	27.0
College/some college education	100	62.9
Parent work status		
Not employed	51	32.1
Part time	37	23.2
Full time	71	44.7
Family income		
<USD41,000/year*	112	69.4
USD41,000−USD69,000/year	25	15.7
>USD69,000/year	22	13.9
Perception of child coordination compared with other children		
Much less coordinated	14	8.8
Somewhat less coordinated	75	47.2
About the same	20	12.6
Somewhat more coordinated	41	25.8
Much more coordinated	9	5.6
Environment correlates		
Home equipment/play spaces	21.64 ± 2.78	(Range, 16−32)

Note: Environment value is presented as mean ± SD.

* Categorized as "low-income", which is defined by a household income of ≤185% of the Federal income guideline for 2016.[23]

Abbreviations: BMI = body mass index; LEAP = Longitudinal Eating And Physical activity.

study attempted to identify the correlates associated with FMS. A broad range of correlates at the child, family, and environment levels were found to be associated initially with locomotor and/or object control skills, as well as strength, indicating that FMS correlates are not only multidimensional, but also specific to the skill type. These observations support the use of the social-ecological framework in understanding the FMS correlates of young children. Our findings are important because identifying the correlates that are associated with specific skills may direct teachers, parents, and health professionals in helping young children to develop and improve motor skill competency.

At the child level, we found that child perceived physical competence was not associated with FMS, which does not align with previous evidence that supports the existence of a strong relationship between FMS and perceived physical competence.[24,25] Because perceived physical competence has been shown to be associated with children's participation in PA,[26] a

possible explanation is that the participating preschools did not provide enough structured physical education classes and/ or activities at baseline; and even if children undertook outside school activities with parents, most of these activities may not have included skill-oriented instruction and practice. This factor may affect how children view themselves. It is also worth noting that ≥80% of the children from these 2 aforementioned studies were African American, whereas 42% of our sample were Hispanic/Latino. That is, racial/ethnic differences among children may affect their perceived competence. Indeed, previous evidence has shown that parents of different races had different perceived competence,[27] despite scant research has proven such difference exists in young children. To test this explanation, we conducted an independent t test and found that White children perceived themselves to have lower physical competence compared to their peers from other racial backgrounds (a mean of 3.07 vs. a mean of 3.29), but no difference was seen between Hispanic/Latino and non-Hispanic/ Latino children. Further research is warranted to explore potential differences in young children's perceived physical competence as it relates to their racial/ethnic background.

In addition, different measurement tools used in various studies may explain some of the disagreement of results related to perceived physical competence. Previous research in this area used the Test of Gross Motor Development-2nd edition (TGMD-2) instead of the BOT-2 used in our study. Specifically, the TGMD-2, is a process-oriented test that emphasizes the quality of the movement, whereas BOT is a product-oriented test that stresses the outcome of the measurement. Thus, each of these measurements has different testing contents and scoring standards. For example, TGMD-2, defines object control as striking a stationary ball, stationary dribbling, kicking, catching, overhand throwing, and underhand rolling, whereas the BOT-2 interprets object control as dropping and catching a ball, catching a tossed ball, dribbling a ball, and throwing a ball at a target. Therefore, future investigations with diverse participant samples and testing tools are necessary to further explore the relationship between FMS and perceived physical competence.

Interestingly, child's perceived cognitive competence was observed to be associated with both locomotor and object control skills. One possible explanation for this finding is that participating parents had relatively high educational levels (89.9% had some college and/or post high school equivalent degree). Because parental characteristics such as parenting style, parenting practices, and parental attitudes are influenced by educational levels and have been found to be associated with their children's self-perception,[28] these characteristics may mediate the relationship between a child's perceived cognitive competence and the parents' education. That is, children are more likely to perceive themselves as more highly competent if their parents have higher educational levels. Our finding suggested that children who perceive themselves as having high cognitive competency tend to have better FMS. Nevertheless, more research on this topic is called for.

At the family level, parents' education was the only factor positively associated with children's locomotor skills in the regression model, despite the fact that parents, BMI and their

Table 3
Bivariate associations between independent and dependent variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Family correlates														
1. Siblings	—	−0.06	−0.22**	−0.18*	0.02	0.22**	−0.04	−0.09	0.13	0.13	−0.02	−0.10	0.13	0.03
2. Age		—	0.19*	0.24**	−0.05	−0.10	−0.01	0.19*	−0.05	−0.06	0.05	0.08	−0.04	0.11
3. Parent education			—	0.23**	0.17*	−0.05	0.16*	0.29**	−0.02	−0.16	0.06	0.18*	−0.07	0.11
4. WS				—	0.11	0.11	−0.03	0.16*	0.04	0.01	−0.4	0.15	0.14	0.13
5. Income					—	−0.19*	−0.03	0.36**	−0.04	−0.09	0.03	0.13	0.02	0.02
6. BMI						—	−0.14	−0.18**	−0.01	−0.02	−0.08	−0.23**	0.01	−0.17*
7. PC							—	0.25**	0.04	0.07	0.06	0.19*	0.13	0.15
Environment correlates														
8. HPE								—	−0.04	0.02	0.01	0.20*	0.01	0.18*
Child correlates														
9. PCC									—	0.50**	0.02	0.14*	0.17*	−0.05
10. PPC										—	−0.02	0.09	0.11	0.09
Dependent variable														
11. Balance											—	0.38**	0.15*	0.33**
12. Locomotor												—	0.32**	0.43**
13. Object													—	0.25**
14. Strength														—

Note: Family and environment correlates ($n = 159$); child correlates ($n = 228$) and dependent variables.
* $p < 0.05$, ** $p < 0.01$.
Abbreviations: BMI = body mass index; HPE = home physical environment; PC = perceived coordination; PCC = perceived cognitive competence; PPC = perceived physical competence; WS = work status.

perception of their child's coordination were close to being significant ($p = 0.07$ *vs.* $p = 0.08$) in relation to their child's locomotor skills. Gutman and Feinstein[29] indicated that parents with higher education levels reported more interactions and undertook more outside activities with their children than did those with less education. This finding was subsequently verified by Giagazoglou et al.,[30] who found that children of highly educated mothers had a higher mean developmental quotient on both locomotor and eye-hand coordination scales. It is important to note that,

even though parents BMI failed to reach significance in the final regression model, children of overweight and/or obese parents may be at risk for developmental delays. Indeed, a recent study has demonstrated a negative association between parental obesity and children's both fine and gross motor skills,[31] indicating the importance of parent characteristics in motor skill development during early childhood.

Child athletic coordination as perceived by the parent was initially positively associated only with locomotor skills. It is

Table 4
Linear regression predicting children's motor skills from child, family, and environment correlates.

Variable	R^2	Adjusted R^2	F	p	B	SE	β	t	p
Locomotor[†]									
FC ($n = 159$)	0.128	0.088	3.17	0.004					
Education					0.89	0.43	0.16	2.10	0.04*
BMI					−0.69	0.39	−0.14	−1.80	0.07
Coordination					0.75	0.42	0.14	1.80	0.07
CC ($n = 228$)	0.057	0.035	2.64	0.024					
Cognitive					1.25	0.59	0.14	2.10	0.04*
EC ($n = 159$)	0.085	0.055	2.83	0.018					
Equipment					0.25	0.11	0.19	2.38	0.02*
Object[†]									
CC ($n = 228$)	0.103	0.083	3.92	0.001					
Cognitive					1.91	0.64	0.19	2.98	0.003**
Strength[†]									
FC ($n = 159$)	0.053	0.022	1.72	0.132					
BMI					−0.59	0.42	−0.12	−1.40	0.08
EC ($n = 159$)	0.062	0.032	2.04	0.070					
Equipment					0.20	0.11	0.15	1.86	0.07

Note: All models are adjusted by age, sex, BMI z-score.
* $p < 0.05$, ** $p < 0.01$; [†] Dependent variables.
Abbreviations: BMI = body mass index; CC = child correlates; EC = environment correlates; FC = family correlates; SE = standard error.

unclear why this would be the case only for locomotor skills, but not for object control skills. It is possible that parents may perceive athletic coordination as more related to locomotor skills that they regularly observe, such as walking, jumping, and hopping, and thus not comprehend that athletic coordination includes more complex movements. This finding suggests that some parents may lack a knowledge and understanding of motor skills development. In fact, previous evidence has shown that mothers overestimate their child's motor skills competence in carrying out certain tasks,[32] and many parents believe that children naturally learn FMS. Thus, these parents may be ambivalent toward the need to deliberately teach FMS to their preschoolers.[33] Therefore, increasing parents' understanding and knowledge of motor skills development is required if they are to have a more accurate perception of their child's motor skills competence. This instruction would also impress on parents the need to provide adequate stimulation and interaction if they want to promote their child's motor skills development.

At the environment level, having PA equipment and/or play spaces present in the home was the only factor positively related with locomotor skills; however, parent BMI was close to reaching significance in the regression model ($p = 0.07$). Current evidence suggests that having a good PA environment in the home is associated with increased moderate-to-vigorous PA and less sedentary behavior in children.[34] Because PA has been positively related to gross motors skills,[35] it is very possible that children's FMS can be improved if they are surrounded by adequate PA equipment and spacious play areas. Our findings in this regard are in line with previous research, suggesting that children with better FMS have been provided with more equipment.[12] Cools et al.[13] found that the frequency with which parents bought new equipment for their child was positively related to their child's motor skills, apparently because having sports- and activity-related equipment in the home provided increased opportunities for their children to practice certain skills. Notably, Bellows et al.[20] indicated that at-risk preschoolers may fall below the norm for FMS owing to the absence of PA equipment in the home. Our finding, along with existing evidence demonstrating that a supportive and stimulating home PA environment may help to develop motor skill competence reinforces the need for having an opportunity-rich PA environment at home to ensure that children reach their full developmental potential.

The main strength of this study was the inclusion of social-ecological variables as independent predictors at the child, family, and environment levels, which made it possible to examine the variables' relationships with specific types of FMS. However, several limitations of this study should be noted when interpreting the findings. First, multiple independent and dependent variables, along with several covariates, substantially reduced the sample size available for analysis (i.e., to 228 participants for the child measures and 159 parent participants for the family and environment measures). Nevertheless, our analysis showed no significant differences on study-related variables, which minimized concerns about sample differences. In addition, our sample may hamper the generalizability of the findings to other populations as the majority of children are white and from low-income families. Finally, causality cannot be inferred owing to the cross-sectional nature of our study. Nevertheless, having a better understanding of the social-ecological correlates of preschool children's FMS is important in the design of intervention programs targeted at young children. Our study sets the stage for the development of experimental trials seeking to promote improvements in preschool children's motor skill competency.

5. Conclusion

The social-ecological correlates of FMS in young children are multidimensional and complex, and vary according to the specific skill type at the child, family, and environment levels. Longitudinal research is warranted to determine the direction of the relationships between the correlates highlighted in this study and FMS.

Authors' contributions

While conducting this study, NZ played a role in performing the data analysis and drafting the manuscript; SLJ played a role in data collection/sorting and editing the manuscript; REB played a role in data analysis and editing the manuscript; LLB played a large role in conceiving and designing the study, overseeing data collection/analysis, and editing the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jshs.2019.01.001.

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