



**SEX DIFFERENCES IN 3-TO-5 YEAR-OLD CHILDREN ´S  
MOTOR COMPETENCE: A POOLED CROSS-SECTIONAL  
ANALYSIS OF 6241 CHILDREN**

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SEX DIFFERENCES IN 3-TO-5 YEAR-OLD CHILDREN'S MOTOR COMPETENCE: A  
POOLED CROSS-SECTIONAL ANALYSIS OF 6241 CHILDREN

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## Abstract

There is some, albeit inconsistent, evidence supporting sex differences in preschoolers' MC, with these observations not uniform when analyzed by age, and cultural groups. Thus, this study examined sex differences across ages in 3-to-5 year-old children's MC. A cross-country pooled sample of 6241 children aged 3-5 years (49.6% girls) was assessed for MC using the Test of Gross Motor Development -2<sup>nd</sup>/3<sup>rd</sup> edition, and children were categorized into groups of age in months. Multiple linear regression models and predictive margins were calculated to explore how sex and age in months affect scores of MC (i.e., locomotor and ball skills), with adjustments for country and BMI. The Chow's Test was used to test for the presence of a structural break in the data. Significant differences in favor of girls were seen at 57-59 and 66-68 months of age for locomotor skills; boys performed better in ball skills in all age periods, except for 42-44 and 45-47 months of age. The higher marginal effects were observed for the period between 45-47 and 48-50 months for locomotor skills ( $F = 30.21$ ; and  $F = 25.90$  for girls and boys, respectively), and ball skills ( $F = 19.01$ ; and  $F = 42.11$  for girls and boys, respectively). A significantly positive break point was seen at 45-47, highlighting the age interval where children's MC drastically improved. The identification of this breakpoint provides an evidence-based metric for when we might expect MC to rapidly increase, and an indicator of early delay when change does not occur at that age.

**Keywords:** early childhood; motor development; fundamental motor skills; sex differences

## 1. Introduction

Early childhood is a critical period for the development of motor competence (MC) <sup>1</sup>, a multidimensional latent construct generally operationalized through the proficiency in performing fundamental motor skills (FMS). FMS are basic movement patterns that form the foundation for more advanced skills required for participation in organized and non-organized physical activities and sports <sup>2</sup>. FMS need to be fostered, learned, practiced, and developed <sup>3</sup> from an early age, and to be consolidated and strengthened over the years <sup>1</sup>. Age-adequate levels of MC during childhood have been linked to more physical activity levels, healthy weight status <sup>4,5</sup>, increased physical fitness <sup>6</sup>, which may result in increased health benefits during later childhood and adolescence <sup>7</sup>. Emerging evidence also suggests MC may moderate the effect of cognitively enriched physical activity on cognitive outcomes, in particular, working memory and social-emotional skills. higher cognitive skills, and higher socio-emotional skills <sup>8</sup>. Conversely, delayed MC can have long-lasting adverse effect on health outcomes, and limit chances for successful participation in physical activity.

Children's and adolescents' MC levels are lower than desirable worldwide <sup>9</sup>. Considering that MC is determined by individual, social, and environmental factors <sup>10</sup>, it is crucial to identify and target specific population groups that are more likely to have low levels of MC. In this sense,

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3 it is well-known that sex has been highlighted as an important correlate of MC <sup>10</sup>. Prior studies  
4 with children and adolescents reported in the Barnett et al. meta-analytic review stated that the  
5 association between sex and MC depends on age and on the skill domains (i.e., locomotor or ball  
6 skills); in favor of boys for object control skills. During the preschool years, the absence of  
7 defining phenotypical sex characteristics could lead to differences between male and female  
8 preschoolers' MC. Yet there is some, albeit inconsistent, evidence supporting sex differences in  
9 preschoolers' MC <sup>11-14</sup>, with these observations not uniform when analyzed by age <sup>15</sup>, and cultural  
10 groups.

11  
12 In 2014, Iivonen and Sääkslahti <sup>16</sup> reviewed the determinants of MC among preschoolers  
13 aged 3-6 years and reported that boys performed better than girls in ball skills, whilst girls  
14 performed better in stability and locomotor skills. It should be noted that these results were based  
15 on studies that used MC assessment tools. Focusing only on Test of Gross Motor Development  
16 (TGMD), Zheng et al. <sup>17</sup> conducted a systematic meta-analytic review examining sex differences  
17 in MC among 3-6 year old children. Results for overall MC based on 16 studies including 1351  
18 boys and 1247 girls highlighted significant differences favoring boys (95% CI 0.03, 0.31;  $p =$   
19 0.02). Further, results based on data from 38 studies and more than eight thousand children  
20 highlighted no differences in locomotor skill proficiency (95% CI 0.15, 0.01;  $p = 0.09$ ), and  
21 significant differences in favor of boys for ball skills (95% CI 0.38, 0.58;  $p < 0.001$ ), which  
22 notably increased with age. In fact, proficiency in ball skills has been systematically associated  
23 with older boys <sup>9</sup>, though the abovementioned systematic reviews usually merged preschool  
24 children (3 -to-5 years -old) with 6 year-old children in the same group, which leads to caution in  
25 the studies' conclusion <sup>17</sup>, as the early years of life comprises a period of rapid growth and  
26 development <sup>18</sup>. Indeed, the global picture of the association between MC and sex during the  
27 preschool years is unclear because evidence covering this period of life is generally focused on  
28 specific age groups (i.e., 3-to-5 years-old). This means that the relationship between MC and sex  
29 during the spectrum of the preschool period is still unknown. To the best of the authors'  
30 knowledge, no research has investigated MC development in terms of age in months and  
31 associated sex differences. The exception is when motor skill data is collected to create instrument  
32 norms. For example, the TGMD - 2<sup>nd</sup> Edition (TGMD - 2) had a sample of 1208, and the 3<sup>rd</sup>  
33 Edition (TGMD - 3) collected data from 862 children. However, these normed datasets only  
34 collected data on 322 children from the ages of 3 to 5 years of age (TGMD-2), and 370 children  
35 (TGMD-3). Moreover, the datasets were designed to be reflective of the United States population  
36 <sup>19</sup>, and therefore may not be generalizable to children in other countries.

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38 Recognizing sex differences in preschoolers' MC should be actively sought if we aim to  
39 promote an equitable increase in children's MC, because sex disparities are reduced if girls have  
40 the same opportunities for mentoring, feedback, practice, and encouragement <sup>20,21</sup>. The  
41 inconsistencies of the body of literature do not allow for conclusive statements regarding sex  
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3 differences in preschoolers' MC, especially from an international perspective. This reinforces the  
4 need for detailed international information on the MC-sex association in the preschool years, to  
5 conceive and implement tailored healthy development promotion actions and policies. Moreover,  
6 cross-cultural pooling of the data allows a solid picture of MC development around the world.  
7 Thus, this study examined sex differences across ages in 3-to-5 year-old children's MC. To do  
8 this we analyzed a cross-country pooled sample of 3-5 year-old children from nine countries.  
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## 14 2. Methods

### 15 2.1 Data sources and participants

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17 This study included data of 3-5 year-old children, aligning with the preschool age range  
18 in most countries. The process of developing a data pool has been described previously<sup>5</sup>. In brief,  
19 from December 2020 up to mid-September 2021, possible collaborators who had assessed 3-to-5  
20 year old preschoolers before the COVID-19 lockdown, with the widely used, validated, and  
21 reliable TGMD-2 or TGMD-3 between 2010 and 2020, were sought and identified using the  
22 following methods: (i) an extensive search on international databases (Web of Science, PubMed,  
23 and Scopus) of the motor competence/competence literature in preschool years; and (ii) a list of  
24 contacts of the International Motor Development Research Consortium – I-MDRC  
25 (<https://www.i-mdrc.com>). Additionally, bibliographic references of the studies identified in the  
26 databases were searched. A total of 39 possible collaborators from 28 countries (Australia,  
27 Belgium, Brazil, Canada, Chile, China, Colombia, England, Finland, Germany, Greece,  
28 Indonesia, Iran, Ireland, Italy, Macedonia, Malaysia, Mozambique, Netherlands, New Zealand,  
29 Norway, Portugal, Spain, South Korea, South Africa, Turkey, USA, and Wales) were identified.  
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38 Preschoolers' data from 20 collaborators, in nine countries (Australia, Belgium, Brazil,  
39 China, England, Iran, Italy, Spain, and USA), from three of the six WHO regions (East Asia &  
40 Pacific, Europe & Central Asia, Eastern Mediterranean, and Latin America & the Caribbean), and  
41 two country specific income levels, according to the World Bank (high and upper-middle) are  
42 reported in this study<sup>22</sup>.  
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46 Data from each collaborator were shared, and securely stored in a cloud store  
47 administered by Coventry University (UK). Data sets from the same country were merged to  
48 facilitate the analysis, thereby operationalizing a country-specific condition as a unit of clustering.  
49 The pooled data included 6241 preschoolers (49.6% girls), aged 3-5 years. A flow diagram  
50 presenting details about the datasets included is shown in Fig 1.  
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54 The smallest country samples were from Iran ( $n = 115$ ), and Spain ( $n = 103$ ), while the  
55 largest samples were from Australia ( $n = 1288$ ), and Italy ( $n = 1338$ ). Almost all participating  
56 countries obtained data from varying locations, with the exception of Spain and England. Three  
57 participating countries (Brazil, China, and USA) provided information from both the 2<sup>nd</sup> and 3<sup>rd</sup>  
58 editions of the TGMD protocol. Detailed information is available in the Supplementary Table 1.  
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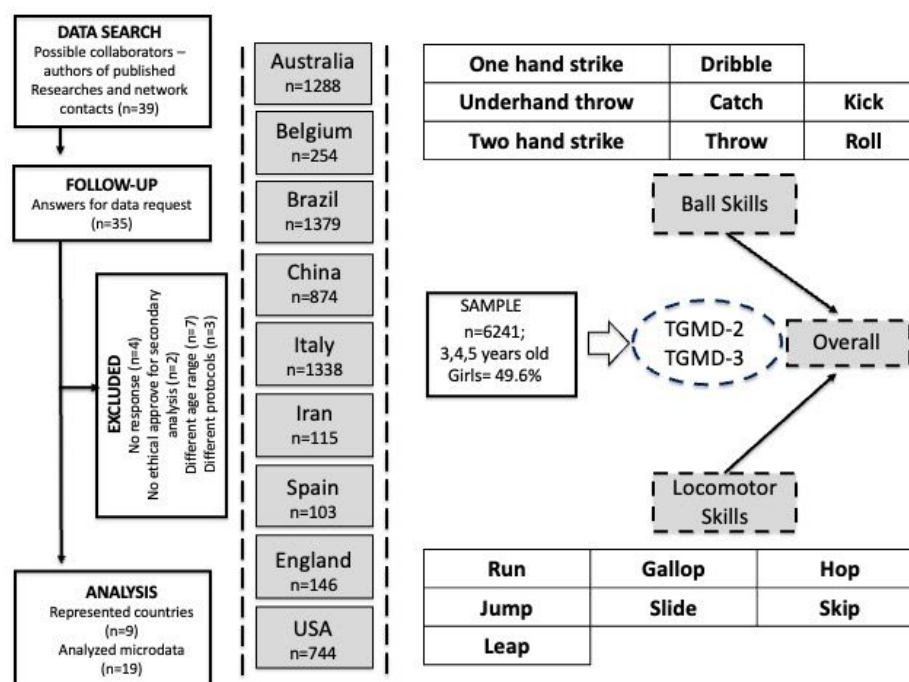


Figure 1: Flow diagram for inclusion in the study

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies were adhered to<sup>23</sup>. Ethics committees in their respective countries approved all the primary studies, ensuring that written informed consent from all parents/ guardians was provided for the original study, and took permission’s responsibility for sharing data for the secondary data analysis.

## 2.2 Measurements

In all studies, child’s sex, body mass index (BMI), and age in months were provided and age was recategorized into three-month groups. Sex and age in months were used as independent variables in the regression models.

Data on MC, including the assessment protocol, were shared by each country contact. For this, the TGMD-2<sup>24</sup> and the TGMD-3<sup>19</sup> were used. The TGMD evaluates gross motor performance in children aged 3 to 10 years, and consists of a protocol to assess process-oriented MC during childhood, including in preschool children. The TGMD involves a comprehensive battery of gross motor skills comprising both locomotor and object-control skills.

The TGMD-2 consists of a two-factor test, with six locomotor skills (run, gallop, hop, leap, jump, and slide) and six object control skills (strike, bounce, catch, kick, overhead throw, and underhand roll). The TGMD-3 test also consists of two factors, but with 13 total skills, six locomotor skills (run, gallop, hop, skip, horizontal jump, and slide) and seven object control skills (one-hand strike, two-hand strike, dribble, catch, kick, overhead throw, and underhand throw).

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3 The criterion validity of the TGMD-3 and the TGMD-2 showed nearly perfect positive  
4 correlations between locomotor skills, ball skills and total scores (all  $r = .98$ )<sup>19</sup>.

6 According to the procedures, children practiced each skill and then performed each skill  
7 twice. For each trial, a child receives a score of “1” if the performance criteria for that skill (e.g.,  
8 *stepping with foot opposite throwing arm*) is performed correctly and a score of “0” if the criterion  
9 is performed incorrectly. The locomotor and ball skills scores are based on the presence (one) or  
10 absence (zero) of each performance criteria. In all but one of the original projects, each  
11 collaborator’s team video-recorded all the trials and later these were assessed by trained assessors  
12 who had prior experience coding this assessment. The exception is for Belgian children, who were  
13 assessed live (not through video recording)<sup>25</sup>. All collaborators who participated in the project  
14 had experience in motor development research and significant experience in using, analyzing, and  
15 interpreting motor skill assessments like the TGMD. Evidence of TGMD assessment reliability  
16 was previously presented in the primary original studies from six countries (Spain, Italy, Brazil,  
17 Australia, Iran, and USA)<sup>25-34</sup>.

### 26 27 2.3 Statistical Analysis

28 All analyses were performed in Stata 18.0. Data from countries were pooled into a single  
29 dataset for analyses, performed for the whole sample. No information imputation was performed,  
30 and missing data, corresponding to 3.9% of the total sample, were excluded for analysis (detailed  
31 information in supplementary table 1). Then, data were stratified by age and sex. Data normality  
32 and homogeneity tests were conducted.

36 To analyze how sex and age in months affect MC, two multiple linear regression models  
37 were conducted considering sex and age as the independent variables, and summed raw scores of  
38 MC (i.e., locomotor and ball skills) as the dependent variables, with adjustments for country and  
39 BMI. The interaction between sex and age was tested. Predictive margins, derived from the  
40 statistical regression model, were calculated for the mean predictions of MC (locomotor skills  
41 and ball skills), which provide an average prediction of MC values for each age group and sex,  
42 controlling for the other variables in the regression model. Subsequently, to assess if significant  
43 differences exist in the domains of MC between each sex and age group, they were estimated  
44 using predictive margins. Then, the slope resultant of the increment / decrease of MC domains in  
45 all pairs of age groups was calculated as follow:  $m = (y_2 - y_1) / (x_2 - x_1)$ , selecting the one with the  
46 steepest slope. Finally, the Chow’s Test<sup>35</sup> was used to test for the presence of a structural break  
47 in the data at an a priori known period of age (the one with the highest calculated slope). For  
48 example, if the contrasts are significant for the interval between 36-38 months, and the slope was  
49 the highest observed, this would suggest a structural break point, if the Chow’s test was  
50 significant.

3. Results

Preschoolers (N = 6241; 50.4% boys) were of a similar age (mean age: 54.36 ± 9.15 months). Descriptive results and the predictive margins showing differences between sexes for locomotor skills and for ball skills, and explained variance means with 95% confidence intervals were calculated and depicted for every age, using the regression coefficients (Table 1; Figure 2). Results show that while significant differences in favor of girls were seen for those at 57-59 and 66-68 months of age for locomotor skills; boys performed better in ball skills in all assessed age periods, except for 42-44 and 45-47 months of age.

\*\*\*\*\* Insert Table 1 \*\*\*\*\*

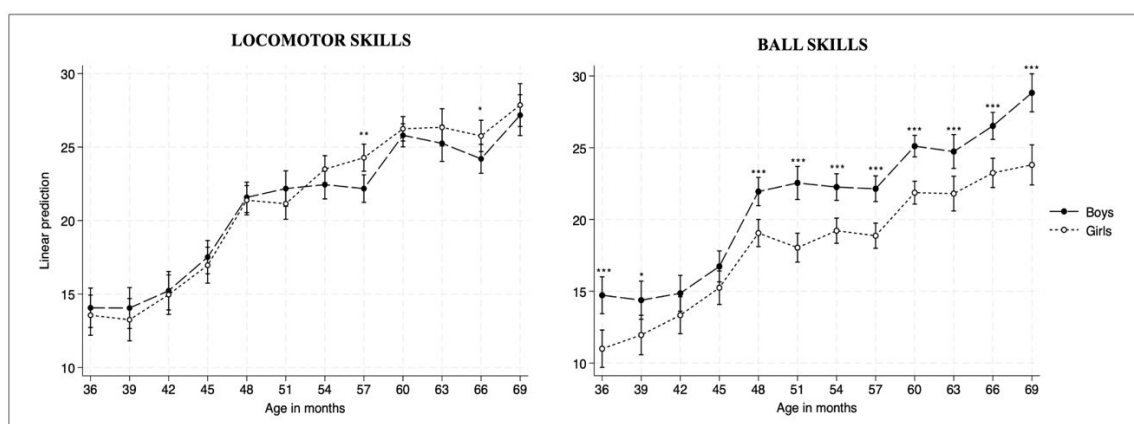


Figure 2: Linear regression models between sex and motor competence according to age in months, with adjustments for country and body mass index. \* p<0.05; \*\* p<0.01; \*\*\* p<0.01

Results of the predictive margins calculated to test the differences between pairs of age groups indicated significant differences between months with the higher marginal effect observed for the period between 45-47 and 48-50 months for locomotor skills (F = 30.21; and F = 25.90 for girls and boys, respectively), and ball skills (F = 19.01; and F = 42.11 for girls and boys, respectively) (Table 2).

Table 2. Marginal effects for comparisons between pairs of age intervals and sex

Age intervals (months)	N	Locomotor skills				Ball skills				
		Girls		Boys		Girls		Boys		
		F	p	F	p	F	p	F	p	
39-41 vs 36-38	150 vs 168	161 vs 172	0.02	0.882	0.12	0.728	1.96	0.162	0.46	0.500
42-44 vs 39-41	172 vs 150	182 vs 161	2.70	0.101	0.90	0.342	1.77	0.165	0.29	0.591
45-47 vs 42-44	209 vs 172	244 vs 182	4.36	<0.037*	5.86	0.016*	4.48	0.034*	5.22	0.022*

48-50 vs 45-47	317 vs 209	291 vs 244	30.21	<0.001*	25.9	<0.001*	19.01	<0.001*	42.11	<0.001*
51-53 vs 48-50	278 vs 317	214 vs 191	0.76	0.382	0.96	0.326	0.64	0.424	1.49	0.222
54-56 vs 51-53	368 vs 278	330 vs 214	11.28	<0.001*	0.00	0.979	2.28	0.131	0.420	0.515
57-59 vs 54-56	368 vs 369	357 vs 330	1.96	0.162	0.13	0.714	0.21	0.646	0.06	0.799
60-62 vs 57-59	447 vs 369	508 vs 357	5.37	<0.021*	34.97	<0.001*	13.96	<0.001*	25.20	<0.001*
63-65 vs 60-62	194 vs 447	205 vs 508	0.60	0.438	0.48	0.489	1.00	0.317	0.03	0.872
66-68 vs 63-65	274 vs 194	322 vs 205	5.27	0.017*	1.64	0.200	3.44	0.063*	4.96	0.026*
69-71 vs 66-68	146 vs 274	162 vs 322	0.58	0.446	1.50	0.221	0.05	0.830	7.88	0.005*

\*  $p < 0.05$

The slopes resultant of all pairs of age intervals were tested as breakpoints in children's MC. Results showed a significantly positive breakpoint, exhibiting 45-47 months as the age interval where children's performance in locomotor (Chow's Test:  $F(4,2792) = 12.59$ ,  $p < 0.001$  and  $F(4,2737) = 19.21$ ,  $p < 0.001$ ) for boys and girls, respectively), and ball skills (Chow's Test:  $F(4,2792) = 7.14$ ,  $p < 0.001$ , and  $F(4,2737) = 14.87$ ,  $p < 0.001$ , for boys and girls, respectively) drastically improved (Figure 3).

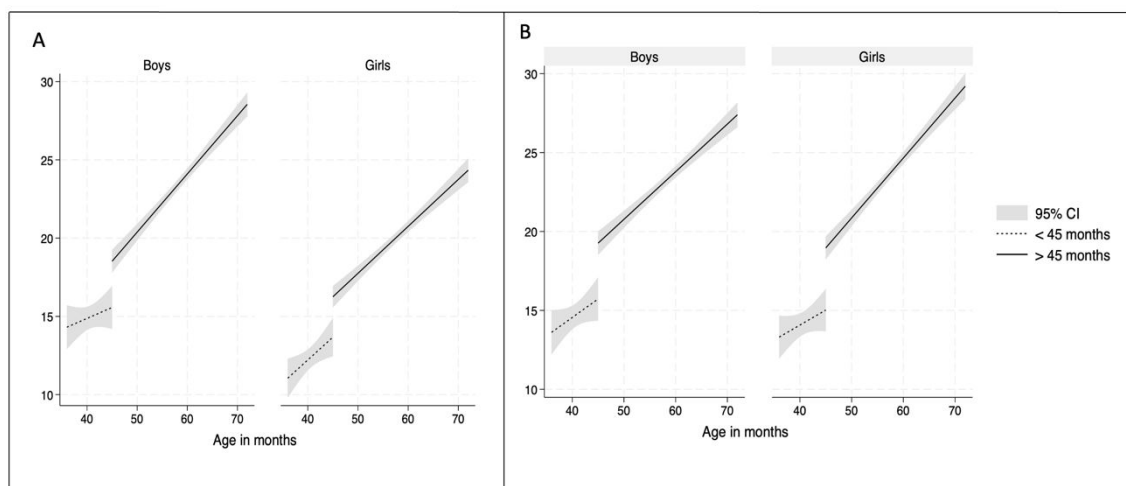


Figure 3: Breakpoint for locomotor (Panel A) and ball skills (Panel B) by sex.

#### 4. Discussion

We examined sex differences across ages in 3-to-5 year-old children's MC. Our main findings highlighted that first, there was a clear increase in children's MC with age. Secondly, boys and girls maintained a similar score in locomotor skills, with the exception at 57-59 and 66-68 months of age (4.75 – 4.92; and 5.5 – 5.67 years of age, respectively), wherein girls outperformed boys. Third, boys exhibited higher ball skills scores than girls, and this was evident right from 3 years old. Girls maintained similar increases over time, however, the difference in ball skills between boys and girls remained, and even increased at the end of preschool. Finally, between 45-47 months (3.75 - 3.92 years of age), a positive breakpoint was detected, demonstrating that children's performance in locomotor and ball skills, for both boys and girls,

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3 drastically improved at this point in their early development. The identification of this breakpoint  
4 represents a step change in work examining sex differences in MC, providing an evidence-based  
5 metric for when we might expect MC to rapidly increase, and an indicator of early delay when  
6 change does not occur at that age.  
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9 Our results regarding an increase in FMS with age reflects developmental validity. As  
10 children age, they tend to have higher FMS scores, as they are able to engage in more movement  
11 experiences and opportunities to enhance their skills, based on opportunities, practice and / or  
12 maturation. This is also evidenced in the correlations' values observed in the TGMD-2 <sup>36</sup>  
13 normative data ( $r = .69$  for locomotor, and  $r = .71$  for object control skills). In TGMD-3 normative  
14 data, this correlation is considered large for locomotor skills ( $r = .65$  and  $r = .62$  for males and  
15 females, respectively), and very large for ball skills ( $r = .74$  and  $r = .76$  for males and females,  
16 respectively).  
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19 In terms of patterns, our study, using the same tool to assess MC in children from different  
20 cultural backgrounds showed similar scores for locomotor skills between boys and girls until the  
21 middle of the 4<sup>th</sup> year of life, where girls outperformed boys. This differed slightly from the  
22 published normative data trends. The norms for the TGMD-2 showed a slightly different picture,  
23 in that for locomotor skills, boys consistently performed lower in terms of raw scores at three  
24 years (19 to 21) and four years of age (27 to 29), and then became more similar in scores at five  
25 years (33 to 32). In the TGMD-3 norms, similar patterns were seen for locomotor skills, where  
26 boys showed lower values than girls at three years of age (15 to 19), at four years of age (22 to  
27 23), and at five years (29 to 30). This pattern changes for the ball skills. In the current study, boys  
28 performed ball skills better than girls from three years of age, and girls' MC in ball skills never  
29 overtook boys after this time point. As such, the differences between boys and girls concerning  
30 ball skills performance remained, and even increased at the end of the examined age period. This  
31 pattern is also reflected in the TGMD-2 norms. For 3-to -5 years-old, boys had higher object  
32 control raw scores than girls at the age of three (20 to 17, and four (25 to 22), and this difference  
33 increased at the age of five 5 (30 to 25). The most recent meta-analytic review on the topic <sup>17</sup>,  
34 which covered children aged 3 to 6 years, found similar evidence to the current study with regard  
35 to skill patterning by sex. Other studies have shown that object control skills are typically better  
36 in boys <sup>17,37-39</sup>, but <sup>40</sup> locomotor skills are less consistent in sex patterning. These inconsistencies  
37 could be attributed to the different protocols used, to individual variabilities, and to cultural  
38 differences.  
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54 The authors of the aforementioned meta-analysis discussed the results based on a  
55 phylogenic perspective, arguing that sex differences observed in ball skills might be related to  
56 boys being more likely to use finely segmented pelvic–torso–shoulder rotation when doing skills  
57 such as throwing <sup>41</sup>, which is related to a warrior background in men and their hitting behaviors,  
58 from an evolutionary approach. The suggestions made by Butterfield et al <sup>41</sup>, in taking an  
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3 evolutionary perspective to explain sex differences in children's gross MC are interesting, though  
4 this approach seems speculative considering the average 21<sup>st</sup> century man is far from a warrior.

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6 There are other potential explanations of why sex differences in gross MC may be  
7 observed. Kokstejn et al <sup>15</sup> analyzed sex differences in MC through the Movement Assessment  
8 Battery for Children—second edition in a sample of 325 preschoolers ( $4.9 \pm 1.1$  y, range 3–6), and  
9 observed that differences are not uniform throughout the whole preschool period, when analyzing  
10 by age. The authors discussed the results based on maturational differences between sexes. Girls  
11 and boys are exposed to distinct brain maturational processes, which could, at least partially,  
12 explain the observed differences. For example, there is a brain area that propels many boys toward  
13 things that move, and many girls toward nurturing <sup>42</sup>. Thus, boys' gross motor skills could tend to  
14 develop slightly faster, while girls' fine motor skills improve first. A previous study with 4- to 11-  
15 year-old children showed that young girls have greater fine motor skills <sup>43</sup> required in activities  
16 demanding a high degree of precision, such as those which typically involve fine manipulation of  
17 objects. For instance, in middle childhood, girls seem faster and better synchronized in fine motor  
18 skills than boys <sup>44</sup>. For this reason, girls may be interested in art (painting, coloring, crafts) before  
19 boys. Also, the brain's pleasure center essentially lights up more for boys when they take risks, what  
20 could lead them to experiment different and challenging activities. That is not to say that girls are  
21 not active risk-takers, only that, on average, boys are more so, and individual variation and  
22 experience also matter. Moreover, from a biological perspective, male babies are born with as much  
23 testosterone as a 25-year-old man, and after birth, testosterone plummets until a boy reaches puberty.  
24 Thus, boys are also more physically aggressive and impulsive, as revealed by studies of their brains  
25 <sup>45</sup>.

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27 The environmental opportunities and affordances children have available to them are  
28 essential in terms of developing motor skills. In an Australian cross-sectional study in preschool  
29 children, homes with more skill related-toys and equipment also had children with better motor  
30 skills <sup>46</sup>. Another Australian study showed that more home equipment for physical activity and  
31 motor skills development when a child was nine months and 3.5 years-old was predictive of better  
32 object control skills <sup>47</sup>. Although this does not explain why boys would have more opportunities  
33 than girls to develop ball skills performance, the study shows that early supportive environmental  
34 opportunities are important to make a difference to both boys' and girls' MC, starting from the  
35 early years of life. In this sense, parents/caregivers' implicit gender bias in providing children  
36 with toys that align with gender stereotypes could lead to these initial proclivities.

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38 It is probable that there is also an ontogenetic explanation, in which boys are encouraged  
39 and given more consistent opportunities from a young age to play with balls and ball-related  
40 objects, thereby socialized by parents or significant others, to engage in more object control  
41 activities. For example, parents of girls have traditionally provided less encouragement for  
42 physical activity, offered fewer sport-related opportunities for their daughters compared to their  
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3 sons, and perceived their sons to have higher sport competence than their daughters <sup>48</sup>. These  
4 factors may exacerbate differences in the opportunities provided for females and males in the  
5 early years. Thus, given that the detection of specific motor deficits in young children might be  
6 of extreme importance for their overall development, in practical terms, it means that we would  
7 need focus on interventions to promote girls' proficiency in gross ball skills, but also to explore  
8 ball skills that girls are more interested and motivated to be engaged, in order to diminish the  
9 observed sex differences along the analyzed periods.  
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14 Gender differentiated behaviors emerge early in development, with children  
15 demonstrating an understanding of gender categories <sup>49</sup>. Thus, girls might not be challenged or  
16 afforded with opportunities to develop their ball skills for much of the time, when compared to  
17 boys. Nonetheless, we need to consider that it may not be just a matter of lack of external stimuli,  
18 but also of girls' individual choices, which are likely greatly influenced by social gender  
19 stereotypes. Based on social cognitive theorists, gender socialization is the consequence of  
20 observational learning and social reinforcement <sup>49,50</sup>. For instance, Miedema et al <sup>51</sup> assessed 84  
21 children aged three years four months to five years seven months to explore associations between  
22 children's stereotypes and actual object control skills performance. Results showed that girls  
23 highlighted higher gender stereotypes about who should do object control skills, in conjunction  
24 with having lower object control skill performances. In another study exploring how parents'  
25 promotion of play may impact gender differences in motor development in infants, parents of  
26 males more frequently made statements to promote gross motor skills while parents of females  
27 more frequently made statements to promote fine motor skills <sup>52</sup>. The abovementioned findings  
28 show that stereotyping starts very early in infancy. Risk taking can be examined from this  
29 perspective. A study in French preschool children showed that boys' and girls' injury-risk behaviors  
30 were predicted by how much children conformed to masculine stereotypes <sup>53</sup>. Another study in  
31 American preschoolers reported that fathers were more careful of their daughters around potential  
32 risks than their sons, thereby helping to form girls' perspectives about the ability to take risks.  
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44 Although age-related changes and improvements are expected during the preschool years,  
45 our results did not reveal significant differences between all the age periods examined. Although  
46 categorizing in 3-months increments allows for a finer-grained analysis of age-related  
47 developments, the absence of age-related differences in locomotor and ball skills during some  
48 periods probably indicates that the 3-month intervals examined were not sufficient to reveal  
49 significant changes in children's MC. Nonetheless, the interval between 45-47 months of age was  
50 highlighted as an important breakpoint of children's performance in locomotor and ball skills for  
51 both boys and girls. This period may coincide with the start of care/preschool for many children.  
52 In early childhood care and education settings, it may also be explained by children being able to  
53 go outside or engage in more varied play with equipment. Another possible social cultural  
54 explanation is that in some countries, this period corresponds to a child's eligibility to engage in  
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3 organized sports in some cultures. A needed next step is to explore in greater depth, the reasons  
4 for this breakpoint, and if it is uniform for all the assessed skills, or MC domains, such as stability,  
5 even using different protocols. Future studies should also focus on understanding environmental  
6 aspects that could modify the observed patterns, such as children's attendance at childcare centers,  
7 participation in organized sports, and parental support for physical activity, for example.  
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## 11 12 13 5. Perspectives:

14 The examination of sex differences in MC is not new. However, the present study  
15 provides a larger overview of sex differences in gross locomotor and ball skills than has been the  
16 case previously. The identification of a distinct breakpoint in children's MC at 45-47 months of  
17 age represents a new insight in the literature related to motor development in early childhood.  
18 Such new information is crucial for researchers, scientists, practitioners, and pediatricians  
19 working in the field. A further understanding of this aspect of sex differences can subsidize the  
20 development of effective interventions to harness the accelerated motor development associated  
21 with the breakpoint. It can also help identify delays in motor development post breakpoint, that  
22 may be modifiable through effective practice and feedback, whilst also gaining insight in how sex  
23 differences between boys and girls may be minimized.  
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## 31 Conflict Of Interest Statement

32 No conflict of interest is reported by any of the authors.  
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## 36 Data Availability Statement

37 The data that support the findings of this study are available from the corresponding author upon  
38 reasonable request.  
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