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Sex Differences in Gross Motor Quotient among Students: Evidence from TGMD-2 Assessment

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Abstract

Objectives. This study aims to assess and compare Fundamental Motor Skills (FMS) using gender-based Gross Motor Quotient (GMQ) scores in elementary school students.

Materials and Methods. The study involved 24 fourth-grade elementary school students (12 boys, 12 girls; M±SD = 10.21±0.41) to assess gross motor skills using the TGMD-2. The locomotor and object-control subtests were assessed in two trials using binary criteria and then converted into standard scores and GMQ values. The analysis included descriptive statistics, normality tests, independent t-tests or Mann-Whitney U tests, and effect size calculations to compare motor skills between genders.

Results. Gross Motor Quotient (GMQ) analysis showed that most students had low gross motor skill levels. The boys' group was in the very poor category (GMQ 58-67) for both locomotor and object-control skills, indicating low uniformity across subtests. The girls' group showed greater variation (GMQ 61-82), but the majority were still classified in the very poor or poor categories. Independent-samples t-tests on the locomotor and object-control subtests showed no significant differences between genders, except for the slide subtest, in which girls performed better ($p = 0.038$). A Mann-Whitney U test on the GMQ confirmed a significant difference between the groups, with girls outperforming boys ($p = 0.005$; effect size = 0.57). These findings confirm the low level of gross motor skills among students and emphasize the need for structured motor learning interventions to improve locomotor and object-control competencies.

Conclusions. Future research should explore game-based adaptive learning models, optimal exercise dosage, and the integration of sensorimotor and motivational approaches to improve elementary school students' GMQ.

Keywords: locomotor, object control, gross motor quotient, fundamental motor skills, differentiated physical education.

Introduction

Fundamental Motor Skills (FMS), which include locomotor skills and object control, are the foundation of students' physical, cognitive, and social development (Piotrowski et al., 2025). While essential, FMS development does not occur automatically with age; children require systematic instruction, sufficient practice, and feedback from trained teachers (Nobre et al., 2018; Valentini et al., 2016). In many schools, physical education instruction still emphasizes free play and general fitness activities, with little focus on specific motor skills, resulting in children often not achieving age-appropriate standards (Barnett et al., 2016). Optimal motor learning requires physical and mental practice, instructional reinforcement, sensorimotor adaptation, variety and frequency of practice, structured feedback, and student motivation (Bates et al., 2026; Leech et al., 2022). This gap underscores the urgency of identifying underdeveloped FMS in elementary school students as a first step to assess students' Gross Motor Quotient (GMQ) and understand the extent of their motor delays. Without systematic evaluation, interventions may be poorly targeted and fail to improve children's motor competence.

Empirical data demonstrate variation in FMS abilities in elementary school students. Students aged 7-9 years show improved locomotor abilities compared to younger ages, but most still fall within the "average" or "below average" category for locomotor skills, and "poor" to "below average" for object control (Lin & Yang, 2015; Mukherjee et al., 2017). In Indonesia, the average locomotor score is 78.7, while object-control skills are much lower, at around 8% (Oktarifaldi et al., 2024). Another study also confirmed that despite high student participation, 90% boys and 92% girls, traditional physical education still fails to provide sufficient motor learning experiences to address children's developmental delays (Makaruk et al., 2025). These data indicate that even though children participate in physical education, their FMS competencies do not meet normative standards, underscoring the need for a comprehensive evaluation before designing interventions. Identification of FMS using the GMQ is an important indicator for understanding motor strengths and weaknesses and for determining development priorities, both in locomotor and object-control aspects.

School environment factors, facilities, gender, and training opportunities also influence the FMS gap in students. Boys tend to show higher FMS scores than girls, particularly in object-control skills, due to a higher frequency of practice and greater interest in ball games (Komaini et al., 2023; Razali et al., 2025). Conversely, girls students face physical barriers and activity preferences that are less conducive to their motor development. Systematically identifying FMS through the GMQ enables teachers to understand each student's individual needs, reduce gender disparities, and determine more appropriate physical education learning strategies. Children with low GMQ in locomotor and object control are at risk of experiencing difficulties in daily physical activities and not achieving age-appropriate developmental standards (Mukherjee et al., 2017; Oktarifaldi et al., 2024). Therefore, measuring the GMQ in elementary school students is a crucial step in designing evidence-based interventions, such as targeted exercises, explicit instruction, and adjustments to the physical education curriculum, to improve children's motor skills optimally.

The purpose of this study was to assess and compare gender-based physical education (FMS) in elementary school-aged children using the GMQ. Systematic evaluation of FMS in elementary school students is a critical step to ensure interventions have a real and sustainable impact. The results of this study support teachers and policymakers in designing effective physical education programs.

Materials and Methods

Study participants

This study involved 24 elementary school students (M±SD = 10.21±0.41) from an elementary school in Bandung, West Java, Indonesia. Participants were 12 boy and 12 girl students. Inclusion criteria included: (1) actively enrolled students, (2) no physical or neurological disorders affecting movement, and (3) written consent from a parent or guardian. Students who were injured or absent during data collection were excluded from the study.

Study organization

This study used a quantitative descriptive-comparative design to evaluate the gross motor skills of elementary school-aged children, specifically fourth-grade students, and to compare motor skills between boys and girl groups. The focus of this study was on measuring gross motor skills using the standardized Test of Gross Motor Development-Second Edition (TGMD-2) instrument developed by Ulrich (2000). The TGMD-2 was chosen for its high reliability and validity and for its ability to measure two main dimensions of gross motor skills: locomotor and object control.

Prior to the measurements, each participant was given a detailed explanation of the measurement procedure and asked to wear sports clothing suitable for physical activity. It was done to ensure participants could move freely and perform each motor skill optimally. Next, each participant completed all TGMD-2 subtests on the school sports field under the supervision of trained researchers who were familiar with the TGMD-2 assessment standards.

During the subtests, each skill was assessed based on predetermined performance criteria. For each criterion, scoring was conducted using a binary system: 1 if the criterion was met and 0 if it was not. Each skill was performed in two formal trials to increase assessment accuracy. All raw scores from each subtest (locomotor and object control) were systematically recorded for each participant and used to convert to standard scores and the Gross Motor Quotient (GMQ).

Instrument

Participants' gross motor skills were assessed using the Test of Gross Motor Development-Second Edition (TGMD-2) developed by Ulrich (2000). This instrument demonstrated good reliability and validity. The internal consistency coefficient for the locomotor subtest was α = 0.85, while the coefficient for the object control subtest was α = 0.88. The Gross Motor Quotient (GMQ) also demonstrated higher internal reliability (α = 0.91). Furthermore, test-retest reliability results demonstrated high consistency, with coefficients of 0.88 for the locomotor subtest, 0.93 for the object control subtest, and 0.96 for the GMQ. It indicates that the TGMD-2 instrument has good measurement stability over time. In terms of construct validity, the loading factor values ranged from 0.49 to 0.75, indicating that each indicator contributes moderately to strongly to the construct being measured. Furthermore, the goodness-of-fit indices also demonstrated good fit, with a Goodness-of-Fit Index (GFI) of 0.96, an Adjusted Goodness-of-Fit Index (AGFI) of 0.95, and a Tucker-Lewis Index (TLI) of 0.90. Therefore, it can be concluded that the TGMD-2 measurement model adequately fits the empirical data.

The locomotor subtest consists of six skills: first, running with four performance criteria. Second, gallop with four performance criteria. Third, hop with five performance criteria. Fourth, leap with three performance criteria. Fifth, horizontal jump with four performance criteria. Finally, slide with four performance criteria.

Meanwhile, the object control subtest also includes six skills: first, striking a stationary ball with five performance criteria. Second, stationary dribble with four performance criteria. Third, catch with 3 performance criteria. Fourth, kick with 4 performance criteria. Fifth, overhand throw with 4 performance criteria. Finally, underhand roll with 4 performance criteria.

Statistical analysis

In the TGMD-2, the assessment of a child's motor skills begins with a raw score obtained through direct observation of locomotor and object-control skills. This score is calculated based on the number of correctly performed movement criteria and does not account for age factors or population norms. Next, the raw locomotor and object control scores are converted into standard scores using normative tables based on age and gender, specifically for students aged 10-11 years, with girl norms used for girls and boy norms for boys. This stage aims to compare children's abilities with their age group more objectively.

The two standard scores from each subtest were then summed and converted back to a GMQ using the TGMD-2 conversion table (Ulrich, 2000) (see Table 1). The GMQ is normative, with a mean of 100 and a standard deviation of 15, allowing for the classification of children's abilities into categories such as below average, average, or above average. Differences between raw scores and the GMQ arise from the gradual conversion process from raw scores to standard scores and then to the GMQ. Furthermore, the use of age- and gender-specific norms can result in children with the same raw score having different standard scores and GMQ scores. The GMQ is also based on a normal distribution, reflecting a child's relative position within the population, not simply the sum of the scores obtained.

Table 1. Descriptive ratings for subtest standard scores and Gross Motor Quotient

Subtest standard scores	Gross motor quotient	Descriptive ratings	Percentage included
17-20	>130	Very superior	2.34
15-16	121-130	Superior	6.87
13-14	111-120	Above average	16.12
8-12	90-110	Average	49.51
6-7	80-89	Below average	16.12
4-5	70-79	Poor	6.87
1-3	<70	Very poor	2.34

Descriptive statistics were calculated for raw scores, standard scores, total standard scores, and GMQ. A normality test was performed to determine the appropriate inferential analysis. For normally distributed data, an independent-samples t-test was performed on the locomotor and object-control subtests. Meanwhile, the Mann-Whitney U test was used to analyze the GMQ between gender groups. Effect sizes were calculated using Cohen's (2013) formula, with the following interpretations: 0.2 (small), 0.5 (medium), and 0.8 (large).

Results

Description of Gross Motor Quotient

Gross Motor Quotient (GMQ) analysis of 12 boys students showed that their gross motor skills were classified as very low. Individual Gross Motor Quotients ranged from 58 to 67, categorized as very poor, in both locomotor and object control domains. Standard scores for each domain also showed uniformity, with locomotor scores ranging from 3 to 6 and object control scores ranging from 3 to 5 (see Table 2). This condition emphasizes the need for more structured motor learning interventions or programs aimed at improving students' locomotor and object control competencies.

Table 2. Gross Motor Quotient Profile of boy students

Participant	Total locomotor	Total object control	Raw score	Standard score locomotor	Standard score object control	Total standard score	Gross motor quotient	Descriptive ratings
1	33	30	63	5	3	8	64	Very poor
2	32	34	66	4	4	8	64	Very poor
3	35	31	66	5	3	8	64	Very poor
4	33	32	65	5	3	8	64	Very poor
5	30	36	66	4	5	9	67	Very poor
6	31	33	64	4	4	8	64	Very poor
7	27	30	57	3	3	6	58	Very poor
8	29	31	60	3	3	6	58	Very poor
9	36	32	68	6	3	9	67	Very poor
10	31	33	64	4	4	8	64	Very poor
11	30	30	60	4	3	7	61	Very poor
12	34	32	66	5	4	9	67	Very poor

Meanwhile, girl students (n = 12) showed greater variation in GMQ, ranging from 61 to 82, with the low category still predominating. Five participants were categorized as very poor, six as poor, and one as below average. Locomotor scores ranged from 24 to 38, while object control scores ranged from 28 to 38 (see Table 3). Interindividual variation was observed, but overall, it indicated that gross motor skills were still limited in most participants. This finding again emphasizes the need for structured motor intervention or learning programs to improve locomotor and object-control skills, so that students' GMQ can be placed in a more adequate category.

Table 3. Gross Motor Quotient profile of girl students

Participant	Total locomotor	Total object control	Raw score	Standard score locomotor	Standard score object control	Total standard score	Gross motor quotient	Descriptive ratings
1	34	30	64	5	5	10	70	Poor
2	36	38	74	6	8	14	82	Below average
3	24	30	54	2	5	7	61	Very poor
4	26	32	58	2	6	8	64	Very poor
5	32	28	60	4	4	8	64	Very poor
6	30	32	62	4	6	10	70	Poor
7	30	31	61	4	5	9	67	Very poor
8	28	33	61	3	6	9	67	Very poor
9	32	33	65	4	6	10	70	Poor
10	38	34	72	7	6	13	79	Poor
11	31	32	63	4	6	10	70	Poor
12	34	32	66	5	6	11	73	Poor

Independent samples t-test (locomotor and object control subtest)

Before conducting the mean difference test, a normality test was first performed on the research variables to ensure the data met the parametric assumptions for both the locomotor and object control (gender) subtests.

Table 4. Tests of normality

Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Locomotor subtest (boys)	0.114	12	0.200*	0.985	12	0.997
Locomotor subtest (girls)	0.128	12	0.200*	0.985	12	0.996
Object control subtest (boys)	0.167	12	0.200*	0.912	12	0.224
Object control subtest (girls)	0.188	12	0.200*	0.912	12	0.249

*. This is a lower bound of the true significance
a. Lilliefors Significance Correction.

Table 5. Testing the locomotor subtest

No	Locomotor subtest	Group statistics (M±SD)		Independent samples t-test		
		Boys (n=12)	Girls (n=12)	t-value	Two sided p	Decision
1	Run	5.33 ± 1.37	4.08 ± 1.93	1.830	0.081	Not significant
2	Gallop	5.75 ± 1.71	4.83 ± 1.27	1.491	0.150	Not significant
3	Hop	6.75 ± 1.06	6.67 ± 0.78	0.220	0.828	Not significant
4	Leap	3.58 ± 0.67	3.92 ± 0.79	-1.113	0.278	Not significant
5	Horizontal jump	5.58 ± 1.44	5.92 ± 1.31	0.592	0.560	Not significant
6	Slide	4.75 ± 1.42	5.83 ± 0.94	-2.203	0.038	Significant
	Total	5.29 ± 1.60	5.21 ± 1.56	0.362	0.721	Not significant

Table 6. Testing the object control subtest

No	Subtest object control	Group statistics (M±SD)		Independent samples t-test		
		Boys (n=12)	Girls (n=12)	t-value	Two sided p	Decision
1	Striking a stationary ball	6.25 ± 1.42	5.92 ± 1.44	0.570	0.575	Not significant
2	Stationary dribble	5.58 ± 1.08	5.33 ± 1.23	0.528	0.603	Not significant
3	Catch	4.17 ± 1.34	4.17 ± 0.58	0.000	1.000	Not significant
4	Kick	5.17 ± 1.53	5.33 ± 1.07	0.309	0.760	Not significant
5	Overhead throw	5.33 ± 0.65	5.92 ± 1.51	-1.232	0.231	Not significant
6	Underhand roll	5.50 ± 0.65	5.42 ± 1.08	0.205	0.840	Not significant
	Total	5.33 ± 1.31	5.42 ± 1.08	-0.094	0.926	Not significant

The results of the normality tests using the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that all study variables did not deviate from normality. For the locomotor subtest, the Kolmogorov-Smirnov statistic values for the boys and girls groups were 0.114 and 0.128, respectively, with p values >0.05. At the same time, the Shapiro-Wilk test showed a value of 0.985 for both groups with p values >0.05 (see Table 4).

For the object control subtest, the Kolmogorov-Smirnov test yielded statistical values of 0.167 (boy) and 0.188 (girl) with p values >0.05, and the Shapiro-Wilk test yielded statistical values of 0.912 (girl) with p values >0.05. This finding indicates that the data meet the assumption of normality, so parametric tests, such as the independent samples t-test, can be applied.

The test results showed no significant differences in most locomotor subtests, including the run (t = 1.830, p = 0.081), gallop (t = 1.491, p = 0.150), hop (t = 0.220, p = 0.828), leap (t = -1.113, p = 0.278), and horizontal jump (t = 0.592, p = 0.560). Similarly, the total locomotor skill score showed no significant difference between boys and girl participants (t = 0.362, p = 0.721) (see Table 5).

However, the slide subtest showed a significant difference (t = -2.203, p = 0.038), with girls participants (M±SD = 5.83±0.94) scoring higher than boy participants (M±SD = 4.75±1.42). It suggests that, while overall locomotor abilities were relatively balanced between the two groups, there were differences in specific skills, such as slide movement.

These findings highlight the potential for more focused interventions to improve skills that show significant differences between the groups.

Further testing results showed no significant differences in any object-control subtests between boy and girl participants. The details are as follows: Striking a stationary ball (t = 0.570, p = 0.575), stationary dribble (t = 0.528, p = 0.603), catch (t = 0.000, p = 1.000), kick (t = 0.309, p = 0.760), overhead throw (t = -1.232, p = 0.231), and underhand roll (t = 0.205, p = 0.840). The total object control score also showed no significant difference between the boys and girls groups (t = -0.094, p = 0.926) (see Table 6).

These results indicate that object-control abilities were relatively equal between men and women in this sample. It confirms that, despite individual variation, there is no overall trend of gender differences in object control skills.

Mann-Whitney U test (differences between boys and girls GMQ)

The Shapiro-Wilk normality test indicated that the GMQ data in the boys group were not normally distributed

Table 7. Tests of normality

Variable	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Gross Motor Quotient (boys)	0.314	12	0.002	0.829	12	0.020
Gross Motor Quotient (girls)	0.234	12	0.070	0.926	12	0.341

*. This is a lower bound of the true significance
a. Lilliefors Significance Correction.

Table 8. Differences in Gross Motor Quotient of participant groups

Descriptive statistics and mean rank				
Variable	**Group**	**N**	**Mean rank**	**Sum of ranks**
Gross Motor Quotient	Boys	12	8.54	102.50
	Girls	12	16.46	197.50
Mann-Whitney U Test				
Variable	**U**	**Z**	**p-value (2-tailed)**	**Description**
Gross Motor Quotient	24.500	-2.814	0.005	Significant
Effect size				
Variable	**Z**	**N**	**Effect size**	**Category**
Gross Motor Quotient	-2.814	24	0.57	Medium

(p = 0.020 < 0.05). In contrast, those in the girls group were normally distributed (p = 0.341 > 0.05). Therefore, a comparative analysis was performed using the non-parametric Mann-Whitney U test.

The Mann-Whitney U test results showed a significant difference in GMQ between boy and girl groups (U = 24.500; Z = -2.814; p = 0.005). Based on the mean rank value, the girls group (16.46) had a higher score than the boys group (8.54). It indicates that gross motor skills in the girls group were better than those in the boys group. The effect size value of 0.57 indicates that the difference is in the moderate category (see Table 8).

Discussion

Overview of the main objectives

The main findings indicate that the majority of students, both boy and girl, have low gross motor skills. Boy students predominantly fell into the very poor category on the GMQ, with subtest scores ranging from 3 to 5, indicating significant delays (see Table 2). Meanwhile, girl students also fell into the low category, although some reached the poor and below-average categories (see Table 3). The results showed that students' gross motor skills were below standard, with an average GMQ score of (M±SD = 66.63±5.69). Referring to the GMQ as a normative transformation based on age and gender (Ulrich, 2000), this score indicates the child's relatively low position relative to their peer group.

Regarding these quantitative findings, further analysis revealed no significant differences between boys and girls on the locomotor or object-control subtests (see Tables 5 and Table 6). However, there were differences in GMQ scores, with girl students performing slightly better, with a medium effect size according to the Mann-Whitney U test (see Table 8). Overall, these findings confirm that elementary school students' gross motor skills remain at a level that requires serious attention. Based on these data, it is important to understand how the FMS's structure explains patterns of student performance.

Fundamentals motor skills structure

The development of Fundamental Motor Skills (FMS) tends to slow after age 7. Although some skills, such as catching a ball, improve around age 10, performance in other skills—such as jumping and throwing—remains inconsistent. In fact, most skills remain at a low level until that age, with only a small number of children achieving mastery. The declining trend in FMS skills from 2000 to 2019 in children aged 6-10 further confirms that low gross motor skills are a global issue, not just a local phenomenon (Chen et al., 2024; Nobre et al., 2018; Valentini et al., 2016).

Given the FMS structure, which consists of two main components: locomotor and object control, the lack of significant differences in each subtest can be explained by the uniform quality of children's motor experiences. Various studies show that the majority of children, both boys and girls, have insufficient levels of FMS, both in school sports programs (72-77%) and traditional physical education (90-92%) (Makaruk et al., 2025). The training experience remains limited and unstructured, resulting in relatively uneven development of basic skills across both main components. As a result, differences in performance between genders at the subtest level are small and not statistically significant. Low physical literacy and a lack of interest in game-based physical education learning also exacerbate this condition, as suboptimal movement experiences hinder the development of overall motor skills (Friskawati & Stephani, 2021; Nugraha et al., 2022).

However, when these two components were integrated into a GMQ composite score, significant differences emerged. It confirms the hierarchical and composite structure of the FMS, in which the accumulation of small differences across multiple aspects, such as coordination, balance, and motor control, can lead to more significant differences at the global level. In this study, girls demonstrated an advantage on the GMQ. Developmentally, girls tend to reach motor maturity earlier, including in coordination and consistency of performance, resulting in more stable performance on structured motor tasks (Toole & Kretzschmar, 1993). Other findings also support a girl advantage in manual dexterity and balance (Navarro-Patón et al., 2021; Smits-Engelsman et al., 2023), although some studies have shown a boy advantage in specific aspects of gross motor skills (Pahlevanian & Ahmadizadeh, 2014).

Behavioral factors such as conscientiousness, adherence to instructions, and better emotional regulation also contribute to the consistent performance of girls (Chaplin & Aldao, 2013). Furthermore, more frequent involvement in fine motor activities also supports improved motor control (Arifiyanti, 2020). Despite reports of boy superiority in manipulative skills (Razali et al., 2025), the accumulation of these factors still results in higher GMQ scores in girls.

Furthermore, environmental and lifestyle factors contribute to low performance on the two main components of the FMS. Children today tend to spend time in sedentary activities, such as more than four hours of screen time for education and one to two hours for recreation, often accompanied by snacking (Rocka et al., 2022; Vanderloo et al., 2022). It negatively impacts physical fitness, muscle strength, coordination, and balance by reducing opportunities for active play. Furthermore, limited sports facilities, safe play spaces, and green open spaces, especially in urban areas, limit children's opportunities to develop locomotor and object control skills optimally (Arufe-Giráldez et al., 2024; Bates et al., 2026).

The combination of a sedentary lifestyle and environmental constraints results in relatively uniformly low gross motor skills across both main components, so that differences at the subtest level are not significant. However, through integration into the GMQ as a more sensitive composite indicator, small variations between individuals can still accumulate and produce clearer differences at the overall level. Overall, these findings suggest that children's motor skills cannot be understood in parts but must be analyzed as a composite system within the FMS structure.

Decision role

To prevent misinterpretation, this study formulated a step-by-step decision rule. First, if locomotor and object control subtest scores do not show significant differences between boys and girls, the analysis should not stop at the subtest level. Second, researchers must proceed to evaluate the composite score, the GMQ, which is considered more representative of Ulrich (2000) version of the TGMD-2. Finally, this GMQ-based decision is crucial because the GMQ combines subtest scores via a normative transformation that accounts for age and gender.

The GMQ's characteristics allow for a more critical assessment of motor skills than raw subtest scores alone. The same raw score can have different standard scores depending on age and gender. For example, a raw locomotor subtest score of 34 can be converted to a standard score of 5 for children aged 9-0 to 10-11, 6 for ages 8-0 to 8-11, and 7 for ages 7-0 to 7-5. As children get older, their standard scores may increase or decrease for the same raw score, indicating that raw scores alone are not sufficient to assess ability relative to peers.

Conversion of object control scores also reveals gender-based differences. For example, a raw score of 34 for girls aged 10-11 to 10-11 translates to a standard score of 6, while a boy with the same score only gets a 4. Another example is a raw score of 36 for girls, a standard score of 7, while a boy gets a raw score of 6. Thus, similar subtest scores do not necessarily reflect similar abilities. The GMQ can reveal latent differences more accurately, thus providing a more critical and relevant basis for evaluating the design of pedagogical interventions.

Pedagogical projection model

Designing pedagogical interventions to improve FMS must be comprehensive and consider specific deficiencies identified through evaluations, ensuring they are not merely general but also target the most lagging skill areas. Research shows that subtests such as hop, leap, and some aspects of object control remain low, indicating the need for more focused training. This approach requires applying critical motor learning principles, including directed practice with systematic repetition and consistent, reflective feedback, enabling students to recognize errors and progressively improve movement technique (Leech et al., 2022; Seckel, 2026). Furthermore, teachers and coaches must be able to adjust the intensity, complexity, and variety of exercises to the student's individual abilities, ensuring the intervention is adaptive and inclusive. This strategy allows each child to develop comprehensive locomotor and object control skills while fostering sustained self-efficacy and motor awareness, rather than simply achieving short-term scores.

Furthermore, an effective pedagogical model must be designed with a clear structure and be adaptable to each student's individual needs. A differentiated instructional approach is crucial, as it allows teachers to identify each child's areas of weakness and tailor training to each child's needs, including duration, difficulty level, and teaching methods (Blegur & Hardiansyah, 2024; Fullerton, 2023; Razali et al., 2024). The application of innovative learning models, such as Teaching Game for Understanding (TGfU) (Gustian et al., 2024), Sport Education Model (SEM) (Tang et al., 2026), Project-based Learning (PjBL) (Simonton et al., 2021), small game competitions (Fizi et al., 2023; Hartati et al., 2022), and other models that offer a fun, contextual approach, thus encouraging student motivation and active participation in the structured motor learning process. By combining targeted practice, adaptive teaching strategies, and meaningful play experiences, the intervention not only targets improvements in locomotor and object-control skills but also strengthens the overall GMQ. This approach emphasizes the development of continuous motor skills, strategic thinking in movement, and active child engagement, ensuring a greater learning impact and avoiding a focus on short-term score achievement.

Practical constraints, such as limited learning time, facilities, equipment, and teachers' opportunities for ongoing competency development, pose significant barriers to the implementation of motor interventions in schools.

Previous research confirms that these limitations directly impact the effectiveness of systematic and targeted motor practice, preventing students from receiving consistent and optimal practice (Blegur, 2025; Hannah et al., 2025; Nielsen-Rodríguez et al., 2021; Oktarifaldi et al., 2024). To address this issue, school-based pedagogical interventions should use games, structured practice modules, and professional development programs to help teachers implement learning strategies adaptively and sustainably. This approach not only ensures the comprehensive development of FMS, both locomotor and object control, but also helps reduce the ability gap between students. Furthermore, planned and systematic motor learning experiences build a strong motor foundation, encourage active physical participation, and facilitate long-term skill acquisition, rather than simply achieving short-term scores.

Research limitations

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size of only 24 children limits statistical power and the ability to detect more subtle differences between groups. The limited sample size also increases the possibility that individual variability influences the results, so the findings may not fully reflect the broader population. Second, the study's local context, focusing only on elementary school students in one city, may limit the relevance of its findings to the geographic, cultural, and educational conditions in other regions. Environmental factors, curricula, and children's physical activity habits in other regions may differ, so the results cannot be directly generalized to the entire population of elementary school children in Indonesia. Third, the generalizability of this study is limited by its focus on a specific FMS subtest, so broader measures of motor skills or related variables such as motivation, health, and family support are not comprehensively covered. These limitations emphasize the need for further research with larger samples and more representative contexts.

Prospects for further research

This research opens the door to further studies that empirically test the effectiveness of motor interventions through experimental and longitudinal designs, for example, by evaluating changes in the GMQ following the implementation of a structured school- or community-based exercise program. Previous evidence suggests that motor interventions can improve basic skills in children with developmental delays, while functional training is effective in locomotor and balance (Goodway & Branta, 2003; Zhang et al., 2024). Furthermore, recreational physical activity programs have been shown to improve fitness and reduce body fat percentage (de Oliveira et al., 2022). Future research should explore the link between motor development and academic, cognitive, and psychosocial aspects, given the influence of sedentary lifestyles and obesity on low motor skills (Bremer & Cairney, 2018). Socioeconomic and environmental factors, including regional variations and the effectiveness of school programs, are also important to analyze (Makaruk et al., 2025). The development of an evidence-based curriculum that is adaptive, differentiated, and emphasizes physical literacy is a top priority to support children's motor development and holistic well-being (Barnett et al., 2016; Bates et al., 2026; Khudolii et al., 2025; Piotrowski et al., 2025; Razali et al., 2025).

Conclusions

This study revealed that locomotor and object control abilities, as measured by the GMQ of fourth-grade elementary school students in Bandung, were below standard (M±SD = 66.63±5.69), indicating significant and potentially systemic motor delays. These findings align with international studies and indicate weaknesses in physical education practices, low-quality learning, and limited exposure to meaningful physical activity. Based on these results, interventions need to be defined in line with the research findings, namely structured, evidence-based, and focused on the sustainable development of FMS. Practical implications include curriculum reformulation, teacher competency enhancement, and the implementation of inclusive school- and community-based physical activity programs. Future research should also explore determinants, including socioeconomic and environmental conditions, as well as the relationship between motor delays and academic, cognitive, and psychosocial development. Overall, these findings emphasize the need for a transformation of physical education that is adaptive, integrative, and oriented toward strengthening children's FMS.

Ethics Approval

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The study protocol was approved by the institutional ethics committee of Universitas Pendidikan Indonesia.

Informed Consent

Written informed consent was obtained from all participants' parents or legal guardians prior to participation in the study. Assent was also obtained from the children before testing procedures.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

AI Transparency Statement

The authors used AI-assisted tools for language editing and manuscript preparation. The authors take full responsibility for the content of the article.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Статеві відмінності коефіцієнта загальної моторики серед учнів: дані оцінювання за тестом розвитку великої моторики

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 10 с., 8 табл., 43 джерела.

Мета дослідження. Це дослідження спрямоване на оцінювання та порівняння фундаментальних рухових навичок у учнів початкової школи за показниками коефіцієнта загальної моторики з урахуванням статі.

Матеріали та методи. У дослідженні взяли участь 24 учні четвертого класу початкової школи (12 хлопців, 12 дівчат; M±SD = 10,21±0,41) для оцінювання грубих моторних навичок за допомогою тесту розвитку великої моторики. Субтести локомоторних навичок і контролю об᾽єкта оцінювалися у двох спробах із використанням бінарних критеріїв, після чого результати були перетворені у стандартні бали та значення коефіцієнта загальної моторики. Аналіз включав описову статистику, тести на нормальність розподілу, незалежні t-тести або тести Манна–Вітні, а також розрахунок величини ефекту для порівняння моторних навичок між статями.

Результати. Аналіз коефіцієнта загальної моторики показав, що більшість учнів мали низький рівень грубих моторних навичок. Група хлопців належала до категорії «дуже низький» (58–67 балів) як за локомоторними навичками, так і за контролем об᾽єкта, що свідчить про низьку однорідність між субтестами. Група дівчат продемонструвала більшу варіативність (61–82 бали), однак більшість також належала до категорій «дуже низький» або «низький». Незалежні t-тести для субтестів локомоторних навичок і контролю об᾽єкта не виявили статистично значущих відмінностей між статями, за винятком субтесту ковзного кроку, у якому дівчата показали кращі результати (p = 0,038). Тест Манна–Вітні для коефіцієнта загальної моторики підтвердив статистично значущу різницю між групами, причому дівчата перевищували хлопців за показниками (p = 0,005; величина ефекту = 0,57). Отримані результати підтверджують низький рівень грубих моторних навичок серед учнів та підкреслюють необхідність структурованих програм моторного навчання для покращення локомоторних навичок і контролю об᾽єкта.

Висновки. Подальші дослідження повинні бути спрямовані на вивчення ігрових адаптивних моделей навчання, оптимального дозування фізичних вправ та інтеграції сенсомоторних і мотиваційних підходів для покращення коефіцієнта загальної моторики учнів початкової школи.

Ключові слова: локомоторні навички, контроль об᾽єкта, коефіцієнт загальної моторики, фундаментальні рухові навички, диференційоване фізичне виховання.

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