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SEX DIFFERENCES IN MOTOR COORDINATION, FUNDAMENTAL MOTOR SKILLS, AND SELF-CONFIDENCE AMONG PRIMARY SCHOOL CHILDREN: A MULTIVARIATE ANALYSIS

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Abstract

Motor development comprises several domains that may not show the same sex-related pattern. This study examined sex differences in motor coordination, fundamental motor skills (FMS), and self-confidence among primary school children. A cross-sectional design was used with 220 students aged 9 to <12 years in Padang, Indonesia (114 boys, 106 girls). Motor coordination was measured with the KTK3+, FMS with the Test of Gross Motor Development–Second Edition (TGMD-2), and self-confidence in physical education with a 40-item questionnaire developed by the researchers. Data were analysed using multivariate analysis of variance (MANOVA) followed by univariate tests at $\alpha = .05$. A significant multivariate difference emerged between sexes (Wilks' $\Lambda = .899$, $F(3, 216) = 8.07$, $p < .001$, $\eta^2p = .10$). Follow-up tests showed that the difference was driven by motor coordination (boys higher than girls, $d = 0.62$), whereas FMS and self-confidence did not differ significantly. The three constructs were also not meaningfully correlated ($|r| \leq .07$). These findings indicate that sex-related differences in motor development are domain-specific. Multidimensional assessment of motor coordination and FMS is therefore needed to identify children's movement-learning needs in primary schools.

Keywords: *Motor Coordination; Fundamental Motor Skills; Self-Confidence; Sex Differences; Primary School Children*

INTRODUCTION

Motor competence is a key component of child development because it supports participation in physical activity, movement learning, and sport (Hulteen et al., 2018). Longitudinal evidence links childhood motor competence with later health-related outcomes (Barnett et al., 2022; Luz et al., 2017), and fundamental motor skills (FMS) are widely regarded as the foundation for more complex movement skills (Logan et al., 2018; Putri et al., 2026). However, FMS proficiency varies considerably across individuals and populations. A global systematic review concluded that children's FMS typically fall in the below-average to average range relative to available norms, with different developmental patterns for locomotor and object-control skills (Bolger et al., 2021). Monitoring motor competence in primary school children is therefore essential, particularly for talent development systems

that depend on sex-sensitive profiles of young children (Johnston et al., 2018; Till & Baker, 2020).

Motor competence is multidimensional and cannot be fully represented by a single indicator. The Körperkoordinationstest für Kinder (KTK) evaluates whole-body coordination through tasks involving balance, lateral movement, and jumping (Coppens et al., 2021; Mardiansyah et al., 2023; Mostaert et al., 2022; Syahputra et al., 2025), whereas FMS assessments focus on the movement quality of locomotor and object-control skills (Hulteen et al., 2015). The KTK captures coordination and balance components that are not identical to those of skill-oriented FMS tests (Nagy et al., 2023). Process- and product-oriented assessments are related but not interchangeable (Logan et al., 2017), and the choice of method determines which aspects of competence are captured (Bardid et al., 2019). Using the KTK and an FMS test together may therefore provide a broader picture than either alone.

Psychological aspects are also relevant in physical education. Self-confidence reflects children's belief in their ability to meet the demands of activity and learning, yet such beliefs do not necessarily mirror actual motor ability. A meta-analysis of 69 studies showed that the relationship between actual and perceived motor competence depends on measurement characteristics, age, sex, and the type of competence assessed (De Meester et al., 2020; Estevan & Barnett, 2018). (Estevan et al., 2021) reported weak-to-moderate associations of actual and perceived competence with motivation for physical education, and studies including work in Indonesia examine actual competence, perceived competence, and physical activity side by side (Bakhtiar et al., 2020; Famelia et al., 2018; Tsuda et al., 2020).

Sex is another important characteristic, and differences between boys and girls are not uniform across skill domains. A pooled analysis of 6,241 preschool children showed sex differences that differed between locomotor and ball skills and changed with age (Martins et al., 2024), and earlier work likewise found that sex differences were not uniform across the preschool period (Kokštejn et al., 2017). Systematic and meta-analytic evidence similarly shows a boys' advantage mainly in object-control skills, whereas locomotor patterns are more complex (Lorenzo-Martínez et al., 2025; Zheng et al., 2022). A multidimensional study of 9- to 14-

year-olds found that sex was related to motor and psychosocial characteristics and that age and maturity must be considered when interpreting such differences (Burton et al., 2025; Malina et al., 2019).

Despite growing research, evidence that simultaneously integrates motor coordination, FMS, and self-confidence in one sample of primary school students, particularly in Indonesia, remains limited. Many studies assess a single domain or instrument, so it is unclear whether sex differences emerge concurrently across motor and psychological indicators. A multivariate approach is appropriate because it analyses several outcomes simultaneously and limits Type I error inflation, provided valid and reliable instruments are used (Hulteen et al., 2015) .

Therefore, this study aimed to examine multivariate sex differences in motor coordination (KTK3+ motor quotient, MQ), FMS (gross motor quotient, GMQ), and self-confidence in physical education among 220 primary school students in Padang, Indonesia, and to identify which indicators contributed to those differences. The associations among the three variables were examined as a secondary aim.

METHOD

Design and Participants

This quantitative study used an observational cross-sectional design. Data were collected in May 2024 in Padang, West Sumatra, Indonesia. Participants were 220 primary school students in grades IV–VI, aged 9 to <12 years: 114 boys (51.8%) and 106 girls (48.2%). They came from three primary schools selected on the basis of [state sampling technique and school selection criteria]; all eligible students in each school were included (total sampling). Inclusion criteria were active enrolment in grades IV–VI, attendance on the day of data collection, parental or guardian consent, and complete data on all variables. A sensitivity analysis indicated that N = 220 provides 80% power ($\alpha = .05$) to detect correlations of $r \approx .19$ and between-group differences of $d \approx 0.38$ (Lakens, 2022).

Instruments and Measurements

Motor coordination. Motor coordination was measured with the KTK3+, which comprises balance beam, jumping sideways, moving sideways, and eye-hand coordination tasks. Each subtest score was converted into a motor quotient (MQ) based on age and sex, and the four values were averaged to obtain the KTK3+ MQ

used in the analyses, following the standardised procedure and normative tables (Bakhtiar et al., 2023; Coppens et al., 2021; Mardiansyah et al., 2024).

Fundamental motor skills. FMS were assessed with the Test of Gross Motor Development–Second Edition (TGMD-2), which covers locomotor and object-control skills scored against specified performance criteria; scores from this test have among the strongest validity and reliability evidence of available tools (Hulteen et al., 2015). Chronological age was calculated from birth and testing dates and used to derive standard scores and the gross motor quotient (GMQ) from the TGMD-2 norm tables (Ulrich, 2000) . Participants who had not yet reached 12 years were referenced to the highest applicable age group in the norm tables.

Self-confidence. Self-confidence in physical education was measured with a questionnaire developed by the researchers from indicators of self-confidence in the physical education learning context, following recommended scale-development procedures (Boateng et al., 2018). Content validity was judged by three experts with relevant competence.

Procedure and Data Analysis

Each instrument's standard procedure was followed, and testers received a briefing and gave uniform instructions and demonstrations. Data were analysed with IBM SPSS Statistics 30. Normality was examined with the Shapiro–Wilk test and skewness and kurtosis z-scores ($|z| \leq 3.29$ considered acceptable; Mishra et al., 2019), and homogeneity of variances and covariance matrices with Levene's test and Box's M. Sex differences in MQ, GMQ, and self-confidence were analysed simultaneously with multivariate analysis of variance (MANOVA); ANOVA-type tests are generally robust to moderate non-normality (Blanca et al., 2017). When the multivariate test was significant, Welch's t-tests were applied to each variable with Bonferroni correction ($\alpha = .05/3 = .017$). Effect sizes were reported as partial eta squared (η^2p) and Cohen's d with 95% confidence intervals. Associations were examined as a secondary analysis with Pearson's correlations, supplemented by Spearman and sex-stratified correlations. All tests were two-tailed ($\alpha = .05$).

RESULT AND DISCUSSION

This section first describes the FMS and motor coordination classifications, then reports sex differences, and finally presents the associations among the variables. Preliminary checks indicated that the data were suitable for multivariate analysis. Although Shapiro–Wilk tests were significant for all three variables ($p \leq .008$), skewness and kurtosis z-scores were within ±3.29 ($|z| \leq 2.95$), variances were homogeneous across sexes (Levene $p > .10$), and covariance matrices were equal (Box's $M = 4.49$, $p = .62$). One extreme KTK3+ value ($z = -3.65$) was identified, but excluding it did not change the multivariate result (Wilks' $\Lambda = .882$, $p < .001$).

Table 1 shows the distribution of GMQ classifications. Most students fell below the average category: 92 (41.8%) were classified as poor and 53 (24.1%) as below average, whereas only 68 (30.9%) were average and 3 (1.4%) above average; none reached the superior categories. The distribution was similar for boys and girls. Motor coordination, presented in Table 2, showed a different profile. Most students (87.3%) were in the normal category, 3.6% were good, and 9.1% showed mild or severe coordination difficulties; boys more often reached the good category (7 vs. 1).

Table 1. Classification of FMS (GMQ) by sex

Category	Boys	Girls	Total	% of total
Very superior	0	0	0	0.0
Superior	0	0	0	0.0
Above average	1	2	3	1.4
Average	32	36	68	30.9
Below average	33	20	53	24.1
Poor	46	46	92	41.8
Very poor	2	2	4	1.8
Total	114	106	220	100.0

Note. Descriptive ratings follow the TGMD-2 classification.

Table 2. Classification of motor coordination (KTK3+ MQ) by sex

Category	Boys	Girls	Total	% of total
High	0	0	0	0.0
Good	7	1	8	3.6
Normal	97	95	192	87.3
Mild coordination difficulties	9	10	19	8.6
Severe coordination difficulties	1	0	1	0.5
Total	114	106	220	100.0

Table 3 summarises the descriptive statistics and univariate comparisons. The MANOVA revealed a significant multivariate effect of sex on the combined

outcomes, Wilks' $\Lambda = .899$, $F(3, 216) = 8.07$, $p < .001$, $\eta^2p = .10$. Follow-up Welch tests showed that boys had higher KTK3+ MQ than girls, with a medium effect (mean difference = 6.15, 95% CI [3.53, 8.77], $d = 0.62$, $p < .001$). By contrast, GMQ did not differ ($p = .855$, $d = 0.02$), and self-confidence showed a small, non-significant difference favouring boys ($p = .093$, $d = 0.23$; Bonferroni $\alpha = .017$). Mann–Whitney tests led to the same conclusions.

Table 3. Sex differences in KTK3+ MQ, GMQ, and self-confidence

Variable	Boys (n = 114) M (SD)	Girls (n = 106) M (SD)	Mean difference [95% CI]	t (df)	p	d [95% CI]	η^2p
KTK3+ MQ	103.18 (10.49)	97.03 (9.23)	6.15 [3.53, 8.77]	4.62 (217.3)	< .001	0.62 [0.35, 0.89]	.09
GMQ	84.79 (10.45)	84.52 (11.39)	0.27 [−2.64, 3.18]	0.18 (212.6)	.855	0.02 [−0.24, 0.29]	.00
Self-confidence	143.75 (16.16)	140.18 (15.15)	3.57 [−0.59, 7.73]	1.69 (218.0)	.093	0.23 [−0.04, 0.49]	.01

Note. Welch's t-tests; Bonferroni-adjusted $\alpha = .017$; d = Cohen's d; η^2p from one-way ANOVA.

Table 4 presents the associations among the variables. Correlations were negligible, and none was statistically significant. The 95% confidence intervals excluded correlations larger than approximately |.20|. Spearman correlations ($|\rho| \leq .09$, all $p > .17$) and sex-stratified correlations ($|r| \leq .15$, all $p > .13$) showed the same pattern.

Table 4. Pearson correlations among KTK3+ MQ, GMQ, and self-confidence

Variable pair	r	95% CI	p
KTK3+ MQ – GMQ	−.02	[−.15, .11]	.755
KTK3+ MQ – Self-confidence	.02	[−.11, .15]	.771
GMQ – Self-confidence	−.07	[−.20, .06]	.308

Discussion

This study showed a significant multivariate difference between boys and girls in motor coordination, FMS, and self-confidence. Follow-up analyses indicated, however, that the difference was driven mainly by motor coordination, whereas GMQ and self-confidence did not differ significantly. Sex-related differences were therefore domain-specific rather than uniform.

The sex difference in motor coordination agrees with evidence that motor competence follows different patterns in boys and girls from early childhood. (Martins et al., 2024) showed in 6,241 preschoolers that sex differences depend on the skill assessed, and (Burton et al., 2025) reported sex-related motor differences among 9- to 14-year-olds, with age and maturity as factors to consider. The KTK3+ has norms by age and sex (Coppens et al., 2021; Faber et al., 2020). Nevertheless, the difference does not show that one sex inherently has superior motor ability. Coordination performance reflects biological development and movement experience. Sex gaps in sport and leisure-time participation have been documented internationally (Hulteen et al., 2017), and maturity can influence performance (Malina et al., 2019); neither was measured here. The result is better understood as a difference on the measured coordination construct than as a universal biological one.

In contrast, GMQ did not differ by sex. This is not fully inconsistent with earlier work because sex differences in FMS depend heavily on the skill: boys tend to excel in most object-control skills, whereas girls outperform boys in stability and some locomotor skills (Lorenzo-Martínez et al., 2025; Y. Zheng et al., 2022). Because GMQ is an aggregate score and the TGMD-2 contains no stability subtest (Nagy et al., 2023), differences in individual skills may be masked.

The mean GMQ of 84.66 and the 43.6% of students classified as poor or very poor indicate that FMS development remains a concern, in line with global evidence that many children do not reach optimal proficiency (Bolger et al., 2021; Lorenzo-Martínez et al., 2025). These classifications are not diagnoses of developmental delay: the TGMD-2 norms were not derived from Indonesian children, and referencing older participants to the highest available age group may lower GMQ values.

No significant association emerged between motor coordination and FMS ($r = -.02$, 95% CI [−.15, .11]). This can be explained by differences in construct and task demands: the KTK3+ emphasises coordinative ability through specific performance tasks, whereas the TGMD-2 evaluates the quality of locomotor and object-control skill execution, and different instruments capture different

dimensions of motor competence (Bardid et al., 2019; Hulteen et al., 2015; Nagy et al., 2023). Even process- and product-oriented measures of the same skill correlate from weakly to strongly depending on skill and age (Logan et al., 2017). The result indicates no meaningful linear association in this sample, not that the two are unrelated in development, since motor competence is linked with health-related outcomes and fitness (Barnett et al., 2022; Utesch et al., 2019).

Self-confidence did not differ by sex and was not significantly correlated with either motor indicator. This should be interpreted cautiously because confidence in physical education differs conceptually from perceived motor competence. (De Meester et al., 2020) showed that actual and perceived motor competence are related but not strongly enough for performance to determine self-perceptions, and (Pullen et al., 2022) reported small associations between motor skill competence and physical self-efficacy. Because the small difference favouring boys (d = 0.23, 95% CI [−0.04, 0.49]) cannot be ruled out, the finding is not proof of equal confidence.

Practically, assessment in physical education should not rely on a single indicator, because coordination and FMS provide different information and self-confidence cannot be inferred from motor performance. The relatively low GMQ indicates a need for systematic FMS instruction for both sexes; early-childhood interventions can improve FMS (Wick et al., 2017), and FMS are associated with physical activity (Bremer & Cairney, 2018; Jones et al., 2020) . A physical literacy perspective supports developing motor and psychological attributes together (Cairney et al., 2019).

This study has limitations. Its cross-sectional design and three schools in Padang limit causal inference and generalisation. Biological maturation, physical activity, sport experience, and the social environment were not analysed, and the self-developed questionnaire requires further psychometric testing. Longitudinal research across wider regions and variables is needed to explain how sex, maturation, movement experience, and educational context interact in children's motor development.

CONCLUSION

This study shows that sex-related differences in motor coordination, FMS, and self-confidence are domain-specific. The multivariate difference was driven mainly by motor coordination, with boys scoring higher, whereas FMS and self-confidence did not differ significantly and the three constructs were not meaningfully correlated. Children's motor development is multidimensional and cannot be represented by one indicator. In physical education, assessing coordination and FMS separately can help teachers identify movement-learning needs without labelling children by sex. Future studies should use longitudinal designs and more diverse samples and consider maturation, physical activity, sport experience, and the learning environment.

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