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# Interactive effects of motor coordination and socioeconomic status on fundamental motor skills

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### ABSTRACT

This study aimed to examine the individual and combined effects of motor coordination and socioeconomic status on Fundamental Motor Skills (FMS) among elementary school students. A quantitative study using a 2 × 2 factorial design was conducted involving 72 students selected through purposive sampling from a population of 101 students at SDN 45 Bungo Pasang, Padang City. FMS were assessed using the Test of Gross Motor Development-2 (TGMD-2), motor coordination was measured using the (KTK), and socioeconomic status was classified based on parental socioeconomic data. Data were analyzed using descriptive statistics and Two-Way ANOVA. Significant differences were found between students with high and low motor coordination ( $p = 0.028$ ) and between students with moderate and low socioeconomic status ( $p = 0.014$ ). A significant interaction effect was also identified between motor coordination and socioeconomic status ( $p < 0.001$ ). FMS development is influenced by both motor coordination and socioeconomic conditions, highlighting the importance of integrating individual motor competence and environmental support in physical education programs.



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## Introduction

Fundamental Motor Skills (FMS) are essential competencies that support children's physical development and lifelong participation in physical activity. FMS encompass locomotor, non-locomotor, and object control skills that serve as the foundation for more complex movement patterns and sport-specific skills (Bourke et al., 2024; Liu et al., 2024; N. Lopes et al., 2025; Yin et al., 2025). Children who demonstrate adequate mastery of FMS are more likely to engage in physical activity, exhibit higher physical competence, and develop greater confidence in movement-related tasks (Kokstejn et al., 2025; Mazzardo et al., 2024; Piotrowski et al., 2025; Rudd et al., 2020; Salters et al., 2025). Consequently, FMS development has become a major concern in physical education because it contributes to children's physical literacy and long-term health outcomes (Karmakar et al., 2026; Zheng et al., 2022).

Despite its importance, previous studies have reported considerable variation in FMS achievement among elementary school students (Bakhtiar et al., 2020; A. P. Dobell et al., 2023; Fernández-Valero et al., 2021; Tsuda et al., 2020). Low levels of FMS may reduce children's participation in physical activities and limit opportunities to acquire advanced motor skills. At SDN 45 Bungo Pasang, preliminary observations revealed that only 24.5% of students demonstrated adequate motor competence, whereas approximately 75.5% were categorized as

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having low FMS proficiency. These findings indicate that FMS remains a significant issue requiring further investigation, particularly regarding factors that may influence students' motor development.

One factor frequently associated with FMS development is motor coordination. Motor coordination refers to the ability to integrate sensory information, neuromuscular control, balance, timing, and movement accuracy to produce effective movement performance (Faber et al., 2020; Iorga et al., 2023). Children with good motor coordination generally perform locomotor and object control skills more efficiently because they can organize body movements accurately and adapt effectively to movement demands (A. Dobell et al., 2020; Newell & Rovegno, 2021; Syahputra, Tomoliyus, et al., 2025). Motor development theory suggests that coordination functions as a prerequisite for acquiring fundamental movement patterns, making it a critical determinant of FMS mastery (Biino et al., 2025; Karadeniz et al., 2023; Petrigna et al., 2022). Empirical evidence has also demonstrated a significant relationship between motor coordination and both locomotor and object control skills among school-aged children (Canli et al., 2023; Fathirezaie et al., 2022).

In addition to individual factors, environmental conditions also contribute substantially to children's motor development. Socioeconomic status (SES), which reflects parental education, occupation, and economic resources, influences children's access to physical activity opportunities, sports facilities, and supportive play environments (He et al., 2024). Children from families with higher SES generally receive greater movement stimulation and have broader opportunities to participate in organized physical activities (Arufe-Giráldez et al., 2024; Su et al., 2022; Tandon et al., 2021). Furthermore, parental educational background may shape awareness regarding the importance of physical activity and motor development during childhood. Conversely, limited socioeconomic resources may restrict access to facilities and reduce opportunities for motor skill acquisition (Campbell et al., 2024; Eyre et al., 2022; Lorenzo-Martínez et al., 2025; Velija & Allen, 2024).

The relationship between motor coordination, socioeconomic status, and FMS can be explained through ecological and motor development perspectives. Ecological theory suggests that children's development is shaped by interactions between individual characteristics and environmental contexts (Huang et al., 2022; Liu et al., 2024). In this regard, motor coordination represents an internal factor that supports movement performance, whereas socioeconomic status represents an external factor that determines the availability of movement experiences and developmental opportunities (Nobre et al., 2023; Pawlowski et al., 2023). Therefore, FMS should not be viewed solely as a product of biological capability or environmental support, but rather as the outcome of interactions between both dimensions.

Previous studies have examined the association between motor coordination and motor competence as well as the influence of socioeconomic status on physical activity and child development. However, most investigations have analyzed these variables independently, and evidence regarding their combined influence on FMS remains limited, particularly among Indonesian elementary school students. Furthermore, few studies have explored whether socioeconomic conditions strengthen or weaken the contribution of motor coordination to FMS development. Therefore, this study aimed to analyze the individual and interactive effects of motor coordination and socioeconomic status on students' Fundamental Motor Skills at SDN 45 Bungo Pasang, Padang City. The novelty of this study lies in examining the interaction between internal and environmental factors simultaneously to provide a more comprehensive understanding of FMS development among elementary school students.

## Method

### Research Design

The present study employed a quantitative research approach utilizing a factorial design with a  $2 \times 2$  Analysis of Variance (ANOVA). This design was selected to examine both the main effects and interaction effects of motor coordination and socioeconomic status on Fundamental Motor Skills (FMS) among elementary school students. The factorial approach enabled a comprehensive analysis of the relationships between the independent and dependent variables.

### Research Participants

The population of this study consisted of all 101 students enrolled at SDN 45 Bungo Pasang Koto Tangah. A total of 72 students were selected as research participants through a purposive sampling technique. This sampling method was employed to ensure that participants met specific inclusion criteria relevant to the study objectives, thereby providing data that accurately represented the characteristics required for the investigation.

### Instrumentation

The data used consisted of primary and secondary data. Primary data included FMS and motor coordination abilities, while secondary data included students' gender and parental socioeconomic status. FMS was measured

using the Test of Gross Motor Development-2 (TGMD-2) measures two major components of FMS, namely locomotor skills and object control skills (Dilandes et al., 2022; Syahputra, Afrian, et al., 2025), while motor coordination was measured using the Körperkoordinationstest für Kinder (KTK) (Bakhtiar et al., 2023; Mardiansyah et al., 2023; Nadia et al., 2023; M. Putri et al., 2024). Data on gender and socioeconomic status were obtained from school administration.

### Data Analysis

Data were analyzed using descriptive statistics to summarize participant characteristics, including the mean, median, and total number of observations. Furthermore, inferential statistical analysis was conducted using a Two-Way Analysis of Variance (ANOVA) to examine the main and interaction effects of the independent variables. All analyses were performed using IBM SPSS Statistics software.

## Results and Discussions

This section presents the findings of the study and the results of the hypothesis testing conducted by the researchers. Table 1 provides a general description of the Fundamental Motor Skills (FMS) data obtained from students at SDN 45 Bungo Pasang, Koto Tengah District, Padang City. Table 2 presents the frequency distribution of students' overall FMS scores.

**Table 1.** Distribution of Fundamental Motor Skills Across Socioeconomic Status and Motor Coordination Groups

GMQ Category	Total n (%)	Moderate SES n (%)	Low SES n (%)	High Coordination n (%)	Low Coordination n (%)
Above Average (111–120)	2 (2.78)	2 (5.56)	0 (0.00)	2 (5.56)	0 (0.00)
Average (90–110)	14 (19.44)	10 (27.78)	4 (11.11)	7 (19.44)	7 (19.44)
Below Average (80–89)	15 (20.83)	8 (22.22)	7 (19.44)	8 (22.22)	7 (19.44)
Poor (70–79)	22 (30.56)	9 (25.00)	13 (36.11)	8 (22.22)	14 (38.89)
Very Poor (<70)	19 (26.39)	7 (19.44)	12 (33.33)	11 (30.56)	8 (22.22)
Total	72 (100.00)	36 (100.00)	36 (100.00)	36 (100.00)	36 (100.00)

Table 1 presents the distribution of Fundamental Motor Skills (FMS) across the total sample and study groups. Overall, most students were classified in the Poor (30.56%) and Very Poor (26.39%) categories, indicating a relatively low level of motor skill proficiency. Students with moderate socioeconomic status demonstrated a more favorable distribution, with 33.34% categorized as Average or Above Average, compared to only 11.11% among students from low socioeconomic backgrounds. Similarly, students with high motor coordination showed a higher proportion of Average and Above Average performance than those with low motor coordination. In contrast, students with low socioeconomic status and low motor coordination were predominantly concentrated in the Poor and Very Poor categories. These descriptive findings suggest that both socioeconomic status and motor coordination are associated with variations in students' FMS achievement.

### Normality Test

The Shapiro–Wilk analysis showed that all groups produced significance values greater than 0.05, indicating that the data were normally distributed. Therefore, the normality assumption required for parametric statistical analysis was satisfied.

**Table 2.** Shapiro–Wilk Normality Test Results

Group	p-value	Decision
High Coordination – Moderate SES	0.559	Normal
High Coordination – Low SES	0.295	Normal
Low Coordination – Moderate SES	0.505	Normal
Low Coordination – Low SES	0.303	Normal

**Table 3.** Homogeneity of Variance Test

Test	Sig.	Decision
Levene's Test	0.873	Homogeneous

Levene's Test yielded a significance value of 0.873, which exceeded the significance threshold of 0.05. This result confirms that the variances among groups were homogeneous, indicating that the assumption of homogeneity required for Two-Way ANOVA was fulfilled.

### Hypothesis Testing

The results of the Two-Way ANOVA demonstrated significant main effects of motor coordination and socioeconomic status on students' FMS. Students with high motor coordination achieved significantly better FMS scores than those with low motor coordination ( $p = 0.028$ ). Similarly, students from moderate socioeconomic backgrounds demonstrated significantly higher FMS performance than students from low socioeconomic backgrounds ( $p = 0.014$ ). Furthermore, a significant interaction effect was identified between motor coordination and socioeconomic status ( $p < 0.001$ ), indicating that the influence of motor coordination on FMS varied according to students' socioeconomic conditions.

**Table 4.** Summary of Hypothesis Testing Results

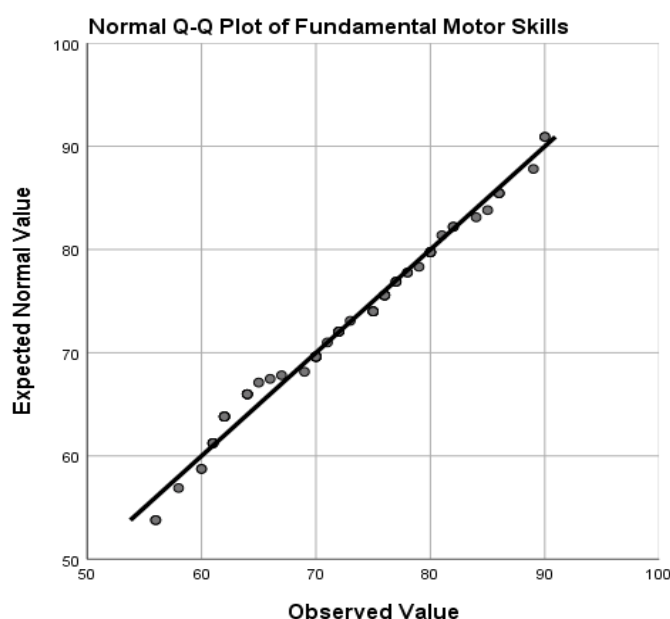
Hypothesis	Statistical Result	p-value	Decision
Difference between High and Low Motor Coordination	Significant	0.028	Accepted
Difference between Moderate and Low SES	Significant	0.014	Accepted
Interaction of Motor Coordination $\times$ SES	Significant	0.000	Accepted
High vs Low Coordination within Moderate SES	$Q = 13.33 > 3.89$	0.000	Accepted
High vs Low Coordination within Low SES	$Q = 6.01 > 3.89$	0.000	Accepted

### Simple Effects Analysis

The follow-up analysis revealed significant differences in FMS scores within both socioeconomic groups. In the moderate SES group, students with high motor coordination achieved substantially higher FMS scores than students with low motor coordination (80.89 vs. 67.83). Similarly, significant differences were observed within the low SES group. These findings further support the existence of an interaction effect between motor coordination and socioeconomic status in influencing students' fundamental motor skills.

**Table 5.** Comparison of FMS Scores within Socioeconomic Status Groups

Group Comparison	Mean Score	Statistical Result
High Coordination + Moderate SES (A1B1)	80.89	
Low Coordination + Moderate SES (A2B1)	67.83	$Q = 13.33 > 3.89$
High Coordination + Low SES (A1B2)	67.39	
Low Coordination + Low SES (A2B2)	73.28	$Q = 6.01 > 3.89$



**Figure 1.** Normal Q-Q Plot of Fundamental Motor Skills (FMS) scores, used to evaluate the assumption of data normality prior to inferential statistical analysis

The findings revealed that Fundamental Motor Skills (FMS) among students at SDN 45 Bungo Pasang were generally low, with 30.56% of students classified as Poor and 26.39% as Very Poor. Furthermore, significant differences were found between students with high and low motor coordination ( $p = 0.028$ ), indicating that motor coordination is an important determinant of FMS mastery. Students with high motor coordination demonstrated superior performance because they were better able to integrate balance, movement timing, and neuromuscular control during locomotor and object control tasks. These findings support motor development theory, which emphasizes coordination as a prerequisite for the acquisition of movement skills, and are consistent with previous studies reporting significant associations between motor coordination and motor competence among school-aged children (A. Dobell et al., 2020; Canli et al., 2023; Faber et al., 2020; Iorga et al., 2023; Newell & Rovegno, 2021; Syahputra, Tomoliyus, et al., 2025).

The study also demonstrated significant differences in FMS between students with moderate and low socioeconomic status ( $p = 0.014$ ). Descriptive findings showed that students from moderate socioeconomic backgrounds had a greater proportion of Average and Above Average FMS categories than students from low socioeconomic backgrounds. These results indicate that family socioeconomic conditions contribute to children's opportunities to engage in physical activity and acquire diverse movement experiences. Access to sports facilities, extracurricular activities, and parental support may provide children with more frequent opportunities to develop movement competence. This finding is in line with previous studies showing that socioeconomic resources influence children's physical activity participation and motor development outcomes (Arufe-Giráldez et al., 2024; Campbell et al., 2024; Eyre et al., 2022; He et al., 2024; Lorenzo-Martínez et al., 2025; Su et al., 2022; Tandon et al., 2021; Velija & Allen, 2024).

A major contribution of this study is the identification of a significant interaction effect between motor coordination and socioeconomic status on FMS ( $p < 0.001$ ). This result indicates that the influence of motor coordination on FMS cannot be fully understood without considering the socioeconomic environment in which children develop. According to ecological perspectives, motor development emerges from interactions between individual characteristics and environmental conditions (Huang et al., 2022; Liu et al., 2024). The present findings extend previous research by demonstrating that motor coordination and socioeconomic status operate simultaneously rather than independently in shaping children's motor competence. Therefore, FMS development should be viewed as a multidimensional process influenced by both biological and environmental factors (Nobre et al., 2023; Pawlowski et al., 2023).

Further analysis showed that among students with moderate socioeconomic status, those with high motor coordination achieved a mean FMS score of 80.89, whereas students with low motor coordination obtained a mean score of 67.83. The significant difference between these groups ( $Q = 13.33 > 3.89$ ) suggests that a supportive socioeconomic environment enhances the benefits of good motor coordination. Children who possess adequate motor coordination are more likely to take advantage of movement opportunities, participate confidently in physical activities, and develop movement skills more effectively. These findings reinforce the view that motor readiness and environmental support complement one another in facilitating motor development (Biino et al., 2025; Iorga et al., 2023; Nobre et al., 2023; Williams & Bentley, 2021).

Interestingly, significant differences were also observed within the low socioeconomic status group. Students with high motor coordination obtained a mean FMS score of 67.39, whereas students with low motor coordination achieved a mean score of 73.28 ( $Q = 6.01 > 3.89$ ). Although this pattern differs from theoretical expectations, it suggests that environmental and experiential factors may influence motor outcomes beyond individual coordination ability alone. Overall, the findings confirm that FMS development is shaped by the interaction between motor coordination and socioeconomic conditions. Consequently, physical education programs should not only focus on improving students' motor competence but also provide equitable movement experiences for children from diverse socioeconomic backgrounds (Fröberg & Lundvall, 2022; Jørgensen et al., 2020; Kirch et al., 2021; Quintriqueo-Torres et al., 2022).

## Conclusions

The study shows that motor coordination and socioeconomic status significantly influence the mastery of FMS of students at SDN 45 Bungo Pasang. The results of the study prove that students with high motor coordination have better mastery of FMS than students with low coordination. In addition, students with medium socioeconomic status also showed better FMS abilities than students with low socioeconomic status. This study also proves an interaction between motor coordination and socioeconomic status on students' mastery of FMS. Thus, all research hypotheses are accepted. Based on these results, physical education teachers are advised to identify students' motor coordination abilities early on as a basis for developing learning programs that are appropriate to students' motor characteristics. Schools also need to provide more varied physical activities and

movement experiences, especially for students with low socioeconomic status, so that the development of basic motor skills can take place optimally and evenly.

## References

- Arufe-Giráldez, V., Pereira Loureiro, J., Groba González, M. B., Nieto Riveiro, L., Canosa Domínguez, N. M., Miranda-Duro, M. del C., Concheiro Moscoso, P., Rodríguez-Padín, R., Roibal Pravio, J., Lagos Rodríguez, M., & Ramos-Álvarez, O. (2024). Multi-Context Strategies and Opportunities for Increasing Levels of Physical Activity in Children and Young People: A Literature Review. In *Children* (Vol. 11, Number 12). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children11121475>
- Bakhtiar, S., Famelia, R., Syahputra, R., Oktavianus, I., & Goodway, J. (2020). Developing a Motor Skill-Based Curriculum for Preschools and Kindergartens as a Preventive Plan for Children With Obesity in Indonesia. *21(Icshpe 2019)*, 106–110. <https://doi.org/10.2991/assehr.k.200824.065>
- Bakhtiar, S., Syahputra, R., Putri, L. P., Mardiansyah, A., Atradinal, Hendrayana, A. A., Afrian, H., Mardela, R., & Pion, J. (2023). Sports talent profile of 7-12 years old: Preliminary study of talent identification in Indonesia. *Journal of Physical Education and Sport*, 23(12), 3167–3177. <https://doi.org/10.7752/jpes.2023.12361>
- Biino, V., Pesce, C., & Martins, C. (2025). Motor Skill Development at Preschool Age in Girls and Boys: The Role of Outdoor Free Play. *Children*, 12(5). <https://doi.org/10.3390/children12050594>
- Bourke, M., Haddara, A., Loh, A., Saravanamuttoo, K. A., Bruijns, B. A., & Tucker, P. (2024). Effect of capacity building interventions on classroom teacher and early childhood educator perceived capabilities, knowledge, and attitudes relating to physical activity and fundamental movement skills: a systematic review and meta-analysis. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-024-18907-x>
- Campbell, A., Lassiter, J., Ertel, M., Taliaferro, A. R., Walker, M. L., & Brian, A. S. (2024). Exploring Facilitators and Barriers to Physical Activity for Families of Rural Preschoolers Participating in a Motor Skill Program. *Children*, 11(3). <https://doi.org/10.3390/children11030362>
- Canli, T., Canli, U., Taskin, C., & Aldhahi, M. I. (2023). Motor Coordination in Primary School Students: The Role of Age, Sex, and Physical Activity Participation in Turkey. *Children*, 10(9). <https://doi.org/10.3390/children10091524>
- D'Anna, C., Forte, P., & Pugliese, E. (2024). Trends in Physical Activity and Motor Development in Young People—Decline or Improvement? A Review. In *Children* (Vol. 11, Number 3). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children11030298>
- Dilandes, A. A., Syahputra, R., Oktarifaldi, O., Putri, L. P., & Bakhtiar, S. (2022). Perbedaan Level Kemampuan Objek Kontrol Berdasarkan Jenis Kelamin dan Usia PAUD. *Jurnal Pendidikan Jasmani Indonesia*, 18(1), 27–35. <https://doi.org/https://doi.org/10.21831/jppi.v18i1.48464>
- Dobell, A. P., Faghy, M. A., Pringle, A., & Roscoe, C. M. P. (2023). Improving Fundamental Movement Skills during Early Childhood: An Intervention Mapping Approach. *Children*, 10(6). <https://doi.org/10.3390/children10061004>
- Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2020). Fundamental movement skills and accelerometer-measured physical activity levels during early childhood: A systematic review. In *Children* (Vol. 7, Number 11). MDPI. <https://doi.org/10.3390/children7110224>
- Eyre, E. L. J., Adeyemi, L. J., Cook, K., Noon, M., Tallis, J., & Duncan, M. (2022). Barriers and Facilitators to Physical Activity and FMS in Children Living in Deprived Areas in the UK: Qualitative Study. *International Journal of Environmental Research and Public Health*, 19(3). <https://doi.org/10.3390/ijerph19031717>
- Faber, I., Zamoscinska, M., Teunissen, J. W., & Pion, J. (2020). The relationship between sport-specific training and a perceptuo-motor skills assessment as part of talent identification in young table tennis players (8-10 years). *International Journal of Racket Sports Science*, 2(1), 42–54. <https://doi.org/10.30827/digibug.63720>
- Fathirezaie, Z., Matos, S., Khodadadeh, E., Clemente, F. M., Badicu, G., Silva, A. F., Sani, S. H. Z., & Nahravani, S. (2022). The Relationship between Executive Functions and Gross Motor Skills in Rural Children Aged 8–10 Years. *Healthcare (Switzerland)*, 10(4). <https://doi.org/10.3390/healthcare10040616>
- Fernández-Valero, P., Soto-Sánchez, J., Páez, J., Leyton-Dinamarca, B., Kain, J., Hurtado, J., & Reyes-Amigo, T. (2021). Fundamental movement skills and physical activity recommendations for preschool children. *Journal of Physical Education and Sport*, 21, 3286–3293. <https://doi.org/10.7752/jpes.2021.s6436>
- Flóres, F. S., Soares, D. P., Willig, R. M., Reyes, A. C., & Silva, A. F. (2024). Mastering movement: A Cross-sectional investigation of motor competence in children and adolescents engaged in sports. *PLoS ONE*,

- 19(5 May). <https://doi.org/10.1371/journal.pone.0304524>
- Fröberg, A., & Lundvall, S. (2022). Sustainable Development Perspectives in Physical Education Teacher Education Course Syllabi: An Analysis of Learning Outcomes. *Sustainability (Switzerland)*, 14(10). <https://doi.org/10.3390/su14105955>
- Galán-Arroyo, C., Mayordomo-Pinilla, N., Castillo-Paredes, A., & Rojo-Ramos, J. (2024). Importance of physical fitness in physical literacy and life satisfaction of Physical Education students. *Importancia de la condición física en la alfabetización física y la satisfacción vital de los estudiantes de Educación Física*. In *Retos* (Vol. 61). <https://recyt.fecyt.es/index.php/retos/index>
- Giuriato, M., Biino, V., Bellafiore, M., Battaglia, G., Palma, A., Baldari, C., Guidetti, L., Gallotta, M. C., Schena, F., & Lanza, M. (2021). Gross Motor Coordination: We Have a Problem! A Study With the Körperkoordinations Test für Kinder in Youth (6–13 Years). *Frontiers in Pediatrics*, 9. <https://doi.org/10.3389/fped.2021.785990>
- He, Y., Zhou, L., Liang, W., Liu, Q., Liu, W., & Wang, S. (2024). Individual, family, and environmental correlates of fundamental motor skills among school-aged children: a cross-sectional study in China. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-024-17728-2>
- Huang, W., Luo, J., & Chen, Y. (2022). Effects of Kindergarten, Family Environment, and Physical Activity on Children's Physical Fitness. *Frontiers in Public Health*, 10. <https://doi.org/10.3389/fpubh.2022.904903>
- Iorga, A., Jianu, A., Gheorghiu, M., Crețu, B. D., & Eremia, I. A. (2023). Motor Coordination and Its Importance in Practicing Performance Movement. *Sustainability (Switzerland)*, 15(7). <https://doi.org/10.3390/su15075812>
- Jørgensen, H. T., Agergaard, S., Stylianou, M., & Troelsen, J. (2020). Diversity in teachers' approaches to movement integration: A qualitative study of lower secondary school teachers' perceptions of a state school reform involving daily physical activity. *European Physical Education Review*, 26(2), 429–447. <https://doi.org/10.1177/1356336X19865567>
- Józsa, K., Oo, T. Z., Borbélyová, D., & Zentai, G. (2023). Exploring the Growth and Predictors of Fine Motor Skills in Young Children Aged 4–8 Years. *Education Sciences*, 13(9). <https://doi.org/10.3390/educsci13090939>
- Karadeniz, S., Suveren, C., Arslan, Y., Ayyıldız Durhan, T., Ceylan, T., Albay, F., Küçük, H., & Ceylan, L. (2023). Examination of basic motor skills in children and adolescents. *Frontiers in Physiology*, 14. <https://doi.org/10.3389/fphys.2023.1346750>
- Kirch, A., Schnitzius, M., Spengler, S., Blaschke, S., & Mess, F. (2021). Knowing Students' Characteristics: Opportunities to Adapt Physical Education Teaching. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.619944>
- Kokstejn, J., Grobar, M., Vampola, J., & Musalek, M. (2025). Why Motor Competence Matters: Fundamental Movement Skills and Their Role in Promoting Physical Activity and Health in Czech Children Aged 9–10 Years. *Journal of Functional Morphology and Kinesiology*, 10(3), 258. <https://doi.org/10.3390/jfmk10030258>
- Kurnaz, M., & Altinkök, M. (2023). Exploring the impact of coordination-based movement education practices on fundamental motor movements and attention skills in 5-6-year-old children. *Journal of Physical Education and Sport*, 23(10), 2567–2583. <https://doi.org/10.7752/jpes.2023.10295>
- Liu, D., Huang, Z., Liu, Y., & Zhou, Y. (2024). The role of fundamental movement skills on children's physical activity during different segments of the school day. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-024-18769-3>
- Lopes, L., Santos, R., Coelho-E-Silva, M., Draper, C., Mota, J., Jidovtseff, B., Clark, C., Schmidt, M., Morgan, P., Duncan, M., O'Brien, W., Chillón, P., Robazza, C., Silva, A., Silva, D., Lima, R., Mourão-Carvalho, I., Khodaverdi, Z., Zequinão, M., ... Agostinis-Sobrinho, C. (2021). A Narrative Review of Motor Competence in Children and Adolescents: What We Know and What We Need to Find Out. *Int. J. Environ. Res. Public Health*, 15, 18. <https://doi.org/10.3390/ijerph1801>
- Lopes, N., Jacinto, M., Monteiro, D., Matos, R., & Ibáñez, S. J. (2025). One Sport or Many? Comparing the Effects of Athletics and Multiactivity Training on Motor Competence in 6–10-Year-Olds—A Case Study. *Journal of Functional Morphology and Kinesiology*, 10(4). <https://doi.org/10.3390/jfmk10040479>
- Lorenzo-Martínez, M., Abelairas-Gómez, C., Carballo-Fazanes, A., & Rey, E. (2025). Prevalence of fundamental movement skill mastery in school-aged children and adolescents: a systematic review. In *BMJ Open Sport and Exercise Medicine* (Vol. 11, Number 4). BMJ Publishing Group. <https://doi.org/10.1136/bmjsem-2024-002439>
- Mardiansyah, A., Syafruddin, M., & Bakhtiar, S. (2023). Assessment of motor competence in Indonesian elementary school children using the Körperkoordinationsstest Für Kinder (KTK3+). *Journal of Physical Education & Sport*, 23(10), 2632–2641. <https://doi.org/10.7752/jpes.2023.10301>
- Marta, I. A., & Syahputra, R. (2025). Studi Deskriptif Fundamental Motor Skills: Analisis Keterampilan

- Lokomotor Siswa Sekolah Dasar Kecamatan Baringin Kabupaten Tanah Datar. *Borneo Physical Education and Sport*, 6(2), 1–9. <https://jurnal.fkip.unmul.ac.id/index.php/bpej>
- Mazzardo, O., Weis, B. M., Sampaio, A. A., de Lima, D. F., de Souza, D. C., & Furtado, O. (2024). Associations Between Fundamental Motor Skill Domains and Physical Fitness Components in 5-11-Year-Old Children. *Perceptual and Motor Skills*, 131(6), 2103–2124. <https://doi.org/10.1177/00315125241284785>
- Nadia, N., Bakhtiar, S., Syahputra, R., Oktarifaldi, O., & Putri, L. P. (2023). A Study of Sports Talent (Characteristics of Elite and Non-Elite Junior Tennis Athletes in Jambi City Based on Gender). *Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan)*, 6(2), 581–592. <https://doi.org/10.31851/hon.v6i2.10962>
- Newell, K. M., & Rovegno, I. (2021). Teaching Children’s Motor Skills for Team Games Through Guided Discovery: How Constraints Enhance Learning. In *Frontiers in Psychology* (Vol. 12). Frontiers Media S.A. <https://doi.org/10.3389/fpsyg.2021.724848>
- Nobre, G. C., Ramalho, M. H. da S., Ribas, M. de S., & Valentini, N. C. (2023). Motor, Physical, and Psychosocial Parameters of Children with and without Developmental Coordination Disorder: A Comparative and Associative Study. *International Journal of Environmental Research and Public Health*, 20(4). <https://doi.org/10.3390/ijerph20042801>
- Park, J., & Jeong, J. (2023). Dribble Accuracy and Arm Coordination Pattern According to Motor Expertise and Tempo. *International Journal of Environmental Research and Public Health*, 20(10). <https://doi.org/10.3390/ijerph20105788>
- Pawlowski, C. S., Madsen, C. D., Toftager, M., Amholt, T. T., & Schipperijn, J. (2023). The role of playgrounds in the development of children’s fundamental movement skills: A scoping review. *PLoS ONE*, 18(12 December). <https://doi.org/10.1371/journal.pone.0294296>
- Petrigna, L., Thomas, E., Brusa, J., Rizzo, F., Scardina, A., Galassi, C., Lo Verde, D., Caramazza, G., & Bellafiore, M. (2022). Does Learning Through Movement Improve Academic Performance in Primary Schoolchildren? A Systematic Review. In *Frontiers in Pediatrics* (Vol. 10). Frontiers Media S.A. <https://doi.org/10.3389/fped.2022.841582>
- Piotrowski, T., Makaruk, H., Tekień, E., Feleszko, W., Kołodziej, M., Albrecht, K., Grela, K., Makuch, R., Werner, B., & Gąsior, J. S. (2025). Fundamental Movement/Motor Skills as an Important Component of Physical Literacy and Bridge to Physical Activity: A Scoping Review. In *Children* (Vol. 12, Number 10). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children12101406>
- Putri, L. P., Syahputra, R., Afrian, H., Naldi, J., & Bakhtiar, S. (2026). Assessing Fundamental Motor Skills And Sex Across Different Age Groups of Elementary School-Aged Children. *Halaman Olahraga Nusantara*, 9(1), 27–38. <https://doi.org/10.31851/hon.v9i1.20115>
- Putri, M., Bakhtiar, S., Bafirman, B., Ihsan, N., & Pratama Putri, L. (2024). The role of learning strategies on object control skills is reviewed from coordination in children. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 10(1), 139–156. [https://doi.org/10.29407/js\\_unpgri.v10i1.22047](https://doi.org/10.29407/js_unpgri.v10i1.22047)
- Quintriqueo-Torres, J., Menares-Quiroz, D., Aguilar-Farias, N., Salvo-Garrido, S., & Carcamo-Oyarzun, J. (2022). Differences in Motor Competence of Chilean Schoolchildren According to Biological and Sociocultural Correlates. *Children*, 9(10). <https://doi.org/10.3390/children9101482>
- Rubi Guzman-Ramos, K., Mohammad Mousavi, S., Jayedi, A., & Kocaadam-Bozkurt, B. (n.d.). Exploring the understanding of how parenting influences the children’s nutritional status, physical activity, and BMI.
- Rudd, J. R., Pesce, C., Strafford, B. W., & Davids, K. (2020). Physical Literacy - A Journey of Individual Enrichment: An Ecological Dynamics Rationale for Enhancing Performance and Physical Activity in All. In *Frontiers in Psychology* (Vol. 11). Frontiers Media S.A. <https://doi.org/10.3389/fpsyg.2020.01904>
- Salters, D., Chauvin, E., Woodruff, S. J., & Scharoun Benson, S. M. (2025). Promoting Fundamental Movement Skills and Physical Literacy Among 8–12-Year-Old Children: Feasibility Insights from an 8-Week Pilot Program in Southwestern Ontario. *Children*, 12(7). <https://doi.org/10.3390/children12070838>
- Šerbetar, I., Loftesnes, J. M., & Mamen, A. (2025). Linking Motor Competence to Children’s Self-Perceptions: The Mediating Role of Physical Fitness. *Children*, 12(10). <https://doi.org/10.3390/children12101412>
- Shi, P., & Feng, X. (2022). Motor skills and cognitive benefits in children and adolescents: Relationship, mechanism and perspectives. In *Frontiers in Psychology* (Vol. 13). Frontiers Media S.A. <https://doi.org/10.3389/fpsyg.2022.1017825>
- Simpson, T., Ellison, P., Carnegie, E., & Marchant, D. (2021). A systematic review of motivational and attentional variables on children’s fundamental movement skill development: the OPTIMAL theory. In *International Review of Sport and Exercise Psychology* (Vol. 14, Number 1, pp. 312–358). Routledge. <https://doi.org/10.1080/1750984X.2020.1809007>
- Stanković, D., Horvatin, M., Vlašić, J., Pekas, D., & Trajković, N. (2023). Motor Coordination in Children: A

- Comparison between Children Engaged in Multisport Activities and Swimming. *Sports*, 11(8). <https://doi.org/10.3390/sports11080139>
- Su, D. L. Y., Tang, T. C. W., Chung, J. S. K., Lee, A. S. Y., Capio, C. M., & Chan, D. K. C. (2022). Parental Influence on Child and Adolescent Physical Activity Level: A Meta-Analysis. In *International Journal of Environmental Research and Public Health* (Vol. 19, Number 24). MDPI. <https://doi.org/10.3390/ijerph192416861>
- Syafruddin, Bakhtiar, S., & Famelia, R. (2020). Children's Motor Skill and Intervention: What Have We Known? <https://doi.org/10.2991/assehr.k.200824.064>
- Syahputra, R., Afrian, H., Naldi, J., Putri, L. P., & Bakhtiar, S. (2025). Profil dan Perbandingan FMS Berdasarkan Usia Siswi SD di Kota Padang. *Borneo Physical Education and Sport*, 6(2), 59–68. <https://jurnal.fkip.unmul.ac.id/index.php/bpej>
- Syahputra, R., Bakhtiar, S., Marta, I. A., & Putri, L. P. (2021). The Profile of Students' Locomotor Skills Level in Elementary School. *Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan)*, 4(2), 138. <https://doi.org/10.31851/hon.v4i2.5378>
- Syahputra, R., Tomoliyus, T., Sugiyanto Sugiyanto, F., Bakhtiar, S., Ockta, Y., Pratama Putri, L., Afrian, H., & Jeprinaldi, J. (2025). The impact of talent detection on increasing the number of children participating in sports. *Retos*, 62, 2025. <https://doi.org/10.47197/retos.v62.111266>
- Tandon, P. S., Kroshus, E., Olsen, K., Garrett, K., Qu, P., & McCleery, J. (2021). Socioeconomic inequities in youth participation in physical activity and sports. *International Journal of Environmental Research and Public Health*, 18(13). <https://doi.org/10.3390/ijerph18136946>
- Tsuda, E., Goodway, J. D., Famelia, R., & Brian, A. (2020). Relationship Between Fundamental Motor Skill Competence, Perceived Physical Competence and Free-Play Physical Activity in Children. *Research Quarterly for Exercise and Sport*, 91(1), 55–63. <https://doi.org/10.1080/02701367.2019.1646851>
- Velija, P., & Allen, G. (2024). 'Every day we'd have an arranged activity, so she'd have football, swimming, dance, gymnastics': A sociological analysis of parenting and sports-based enrichment activities for the under-fives. *International Review for the Sociology of Sport*, 59(6), 903–920. <https://doi.org/10.1177/10126902241238236>
- Wang, G., Zi, Y., Li, B., Su, S., Sun, L., Wang, F., Ren, C., & Liu, Y. (2022). The Effect of Physical Exercise on Fundamental Movement Skills and Physical Fitness among Preschool Children: Study Protocol for a Cluster-Randomized Controlled Trial. *International Journal of Environmental Research and Public Health*, 19(10). <https://doi.org/10.3390/ijerph19106331>
- Weiss, M. R. (2020). Motor skill development and youth physical activity: A social psychological perspective. In *Journal of Motor Learning and Development* (Vol. 8, Number 2, pp. 315–344). Human Kinetics Publishers Inc. <https://doi.org/10.1123/JMLD.2020-0009>
- Wilhite, B. C., Chui, K., Scheck, J. M., Hatfield, D. P., Morris, M., Ziembowicz, M., Herrick, S., & Hennessy, E. (2025). Getting an Active Start: Assessing the Impact of a Physical Literacy-Based Intervention on Preschool-Aged Children's Fundamental Movement Skills, Motor Competency and Behavioral Self-Regulation. *International Journal of Environmental Research and Public Health*, 22(12). <https://doi.org/10.3390/ijerph22121861>
- Williams, K. E., & Bentley, L. A. (2021). Latent Profiles of Teacher-Reported Self-Regulation and Assessed Executive Function in Low-Income Community Preschools: Relations With Motor, Social, and School Readiness Outcomes. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.708514>
- Yang, Y., Mao, X., Li, W., Wang, B., & Fan, L. (2024). A meta-analysis of the effect of physical activity programs on fundamental movement skills in 3–7-year-old children. In *Frontiers in Public Health* (Vol. 12). Frontiers Media SA. <https://doi.org/10.3389/fpubh.2024.1489141>
- Yin, X., Zhang, D., Shen, Y., Wang, Y., Wang, Z., & Liu, Y. (2025). Effectiveness of school-based interventions on fundamental movement skills in children: a systematic review and meta-analysis. In *BMC Public Health* (Vol. 25, Number 1). BioMed Central Ltd. <https://doi.org/10.1186/s12889-025-22696-2>
- Zheng, Y., Ye, W., Korivi, M., Liu, Y., & Hong, F. (2022). Gender Differences in Fundamental Motor Skills Proficiency in Children Aged 3–6 Years: A Systematic Review and Meta-Analysis. In *International Journal of Environmental Research and Public Health* (Vol. 19, Number 14). MDPI. <https://doi.org/10.3390/ijerph19148318>