



Relationship Between Fundamental Movement Skills Proficiency and Physical Fitness Among Fourth-Grade Elementary School Students

Syed Kamaruzaman bin Syed Ali¹, Suthana Tingsabhat², Naufal Krisna Akbar Ananta^{3*}

¹Faculty of Education, Universiti Malaya, Kuala Lumpur, Malaysia

²Faculty of Education, Chulalongkorn University, Bangkok, Thailand

³Faculty of Sport and Health Science, Universitas Negeri Surabaya, Surabaya, Indonesia

*Correspondence Email: 24060464224@mhs.unesa.ac.id

ABSTRACT

Article Info:

Received: 19-09-2026

Revised: 29-09-2026

Accepted: 30-09-2026

Online: 30-09-2026

Keywords:

motor skills; physical
condition; tgmd-3;
tkpn; primary school

Fundamental Movement Skills (FMS) are an important part of children's gross motor development. Their association with physical fitness has been reported in previous studies, but evidence among elementary school students in Indonesia is still limited. This study examined FMS proficiency and physical fitness among fourth-grade students at SDN 03 Kanigoro, Madiun City. A quantitative cross-sectional study was conducted using an analytic observational approach. The population consisted of 28 students, and 27 students were included in the analysis through purposive sampling because one student was absent due to illness. FMS was measured with the Test of Gross Motor Development–Third Edition (TGMD-3), and physical fitness was assessed using the Nusantara Student Fitness Test (TKPN). Category distributions were described using descriptive statistics. The association between FMS proficiency and physical fitness was examined with the Fisher-Freeman-Halton exact test because the requirements for Pearson's chi-square test were not met. Among the 27 students, 37.0% were classified as *Impaired or delayed*. For physical fitness, 51.9% were classified as *Fair* and 48.1% as *Good*. The Fisher-Freeman-Halton exact test gave an *Exact Sig. (2-sided)* value of 0.514, showing no statistically significant association between FMS proficiency and physical fitness. The findings suggest that FMS and physical fitness should both be considered in elementary school physical education.



INTRODUCTION

Physical fitness involves a variety of individual attributes related to a person's responsiveness in performing work effectively without being affected by fatigue or lethargy; rather, an individual has sufficient energy to participate in recreational activities and respond efficiently during emergency situations (ACSM's, 2021; Kristiyandaru et al., 2023). For preschool and school-aged children, physical fitness is an essential aspect of physical health because it is closely connected with cardiovascular performance, physical development, functional capacity, and well-being (Liu et al., 2023; Ortega et al., 2008). Previous research has shown that low physical capacity may ultimately lead to negative long-term consequences in the future, such as metabolic syndrome, lower quality of life, and an increased risk of obesity and chronic diseases from adolescence to adulthood (Ortega et al., 2008). Several studies have indicated that students with superior levels of fitness tend to perform improved in tests of cognitive ability and academic accomplishment (Donnelly et al., 2017). According to the Ministry of Youth and Sports of the Republic of Indonesia, through a study using the Sport Development Index (IPO), Indonesia had an IPO score of 0.334 in 2024, which remained below 1 on a scale ranging from zero to one. The IPO is applied using nine dimensions and also produces a physical fitness index score of 0.196, which is considered one of the lowest scores among these dimensions (Mutohir et al., 2024). Another indication that physical fitness remains a problem is its continued presence within the domain of school-aged children. Therefore, this involves assessing physical fitness in children, encompassing various dimensions and factors that are closely related.

Children's physical fitness levels have been found to correlate with various elements such as age, sex, and nutritional status, as well as other variables such as Physical Activity (PA) and Motor Skills or what is often referred to as Fundamental Movement Skills (FMS) (Nur et al., 2025), each of which is a crucial indicator of physical health in children by examining various components, including cardiorespiratory fitness, muscular strength, body composition, and flexibility. In addition, FMS provides the foundation for more complex movement skills (i.e., locomotor skills: running, object control, and body stability) (Yang et al., 2024). FMS has also been related with components of physical activity and physical fitness in the course of childhood (Liu et al., 2023; Malambo et al., 2022). This condition makes FMS a vital component for targeting physical activity in children.

However, only a finite number of studies are available to assess the association between FMS and physical fitness in children. This is also demonstrated in components of physical fitness, particularly cardiorespiratory endurance as well as muscular strength & endurance (Liu et al., 2023; Lubans et al., 2012), flexibility (Behan et al., 2022), as well as body composition. Indirect evidence may also be supported by physical fitness and health status as outcomes of insufficient FMS; therefore, the use of short-duration exercise programs (i.e., < 45 minutes), ideally designed and supervised, is highly necessary to improve children's approach to lifelong participation in physical activity (Bardid et al., 2021; Wu et al., 2021; Xie et al., 2023). However, inconsistent results have also been observed in many studies inspecting the relationship between FMS and fitness indicators, including BMI and flexibility, with limited supporting literature (Lubans et al., 2012). Further study with diverse



sample characteristics and methods that distinguish these associations is necessary to establish the connection between FMS and physical fitness more definitively.

Although hundreds of scientific papers have been published reporting strong evidence regarding the association between FMS and physical fitness, there is substantial heterogeneity in sample characteristics and the measures/indicators used. The findings should be interpreted within the context of where they were published. A systematic review (Liu et al., 2023) consisting of 49 studies showed that various instruments and protocols were used to measure FMS and physical fitness. Based on these publications, studies on FMS in Indonesia have also only recently begun to be conducted, particularly using TGMD-3 as an instrument for assessing fundamental movement skills. Nevertheless, only a few studies have explored the connection between FMS proficiency levels and physical fitness performance using TGMD-3 and TKPN among elementary school students. Finally, a review of the literature indicates that research on FMS proficiency levels and physical fitness in Madiun City remains very limited. This condition indicates that empirical data regarding children's FMS proficiency levels and physical fitness are still needed for Madiun City, Indonesia.

To the extent of the available empirical evidence, this study is novel because several researchers have begun to search the relationship between Motor Skills or Fundamental Movement Skills (FMS) proficiency and fitness levels using a combination of the Test of Gross Motor Development-Third Edition (TGMD-3) and the Nusantara Student Fitness Test (TKPN) among fourth-grade elementary school students in Madiun City. The purpose of this research is to provide empirical information regarding the relationship between FMS and physical fitness to support primary education in Indonesia, as well as to provide information for the development of Physical Education learning models aimed at improving students' movement quality and children's muscular health. This study will determine the level of FMS proficiency associated with physical fitness levels among fourth-grade children in elementary schools in Madiun City. Through this research, elementary school students will not only focus on developing fundamental movement skills but will also be introduced to and taught about physical fitness from an early age.

METHODS

This study used a quantitative approach with an analytic observational and cross-sectional design. A *cross-sectional* design is an observational design that measures research variables during a single observation period, allowing the relationship between variables to be analyzed at the same time (Rezigalla, 2020; Setia, 2016). This study aimed to analyze the relation between the level of *Fundamental Movement Skills* (FMS) proficiency and the level of physical fitness among fourth-grade elementary school students.



Participants and Sampling

The study involved 28 fourth-grade students from SDN 03 Kanigoro, Madiun City. The participants were selected using *purposive sampling* (Maksum, 2018). The selection was based on the study criteria, which included students who were registered as fourth-grade students at SDN 03 Kanigoro, Madiun City, and were able to take part in all measurement procedures. During data collection, one student was absent because of illness. Therefore, only 27 students completed all measurement procedures and were included in the data analysis.

Table 1. Population and Sample Selection

Sample Selection Stage	Number (n)
All fourth-grade students at SDN 03 Kanigoro	28
Students absent due to illness	1
Final sample analyzed	27

Administrative records showed variation in the ages of the fourth-grade students. At the time of data collection on September 7, 2026, the 27 participating students were between 8 and 11 years old, with a mean age of 9.44 years. The age distribution consisted of 2 students aged 8 years, 12 students aged 9 years, 12 students aged 10 years, and 1 student aged 11 years. Thus, students in the same grade did not share an identical age distribution. Accordingly, fourth-grade status was used to characterize the population and sample rather than a specific age group.

Based on sex, of the 27 students who participated in all measurement procedures, 16 students were male (59.3%) and 11 students were female (40.7%). This composition indicates that the study sample consisted of male and female students with different proportions.

Table 2. Characteristics of Participants

Characteristic	Category	Number (n)	Percentage (%)	
Age	8 years	2	7.4	Mean age 9.44 years
	9 years	12	44.4	
	10 years	12	44.4	
	11 years	1	3.7	
Sex	Male	16	59.3	
	Female	11	40.7	
Total		27	100	



Instruments and Apparatus

Test of Gross Motor Development–Third Edition (TGMD-3)

The TGMD-3 was used to measure gross motor skills in children aged 3 years to 10 years 11 months (Ulrich, 2019). One participant was 11 years and 4 months old at the time of data collection; therefore, the highest available age norm (10 years 11 months) was used for score interpretation. It contains 13 skills shared into two parts, specifically Locomotor Skills and Ball Skills. These locomotor skills contained the run, gallop, hop, skip, horizontal jump, as well as slide. The ball skills include two-hand strike of a stationary ball, one-hand forehand strike, stationary dribble, two-hand catch, kick, overhand throw, and underhand throw.

The TGMD-3 was completed separately by each participant. The examiner first explained and demonstrated each movement before the testing started. Each participant then had one trial to practice the movement, followed by two trials used for scoring. The scoring was based on the performance criteria in the TGMD-3 manual. A criterion received 1 point when the required movement was performed correctly and 0 points when it was not met.

For each skill, the scores from the two formal trials were added together to obtain the skill score. The skill scores were then combined separately for the two test components, resulting in the Locomotor Raw Score and *Ball Skills Raw Score*. Each raw score was converted to a scaled score using the age norms. The two scaled scores were then combined to obtain the total scaled score. This score was used to determine the *Gross Motor Index* (GMI) and percentile rank in accordance with the TGMD-3 manual. The GMI represented the participant's overall gross motor ability. The use of the TGMD-3 is also supported by psychometric research demonstrating a two-factor structure, namely *Locomotor Skills* and *Ball Skills*, together with high *test-retest* reliability among children from different age groups (Magistro et al., 2020).

Nusantara Student Fitness Test (TKPN)

Physical fitness was measured with the Nusantara Student Fitness Test (TKPN), following the 2022 Pedoman Pelaksanaan Nusantara Student Fitness Test (Kementerian Pemuda dan Olahraga Republik Indonesia, 2022). The TKPN covers *Body Mass Index* (BMI), *V-Sit and Reach*, *Sit-Up* for 60 seconds, *Squat Thrust* for 30 seconds, and the *Progressive Aerobic Cardiovascular Endurance Run* (PACER). In the present study, BMI was recorded as the anthropometric measure. The physical fitness level was based on four components of the test: *V-Sit and Reach*, *Sit-Up* for 60 seconds, *Squat Thrust* for 30 seconds, and PACER.

Flexibility was assessed using the *V-Sit and Reach test*. During the test, participants sat on the floor with their legs extended forward and apart in a V position, keeping both knees straight. They then placed their hands together and reached forward as far as they could following the test procedure. Three trials were carried out, and the farthest reach obtained was recorded as the test result in accordance with the TKPN assessment procedures.



Abdominal muscular endurance was assessed using the 60-second *Sit-Up test*. Each participant performed *sit-ups* for 60 seconds, following the procedure specified in the TKPN guidelines. The final score represented the number of repetitions correctly completed during the test. The 30-second *Squat Thrust test* assessed the ability to perform repeated movements continuously for 30 seconds. Participants completed the *squat thrust* exercise for the full 30-second period using the technique specified in the TKPN guidelines. The score was based on the number of repetitions that were performed correctly during the test.

The *Progressive Aerobic Cardiovascular Endurance Run* (PACER) was conducted to assess cardiorespiratory endurance. Participants ran repeatedly between two lines set 20 meters apart, with the running pace increasing progressively in response to an audio signal. Each shuttle required the participant to reach the opposite line before the next signal was heard. The test was stopped when the participant completed the test or had two failures or delays in reaching the line, as specified in the TKPN requirements. The level reached and the number of successful shuttles were recorded as the test results.

The four physical fitness components were interpreted using the TKPN criteria according to each participant's age and sex. Component scores were calculated using the proportions specified in the guidelines: 50% for PACER, 20% for *Squat Thrust*, 20% for *Sit-Up*, and 10% for *V-Sit and Reach*. The scores from these four components were then combined to obtain the physical fitness score, which had a maximum value of 5.

Procedures / Data Collection

Data collection took place at SDN 03 Kanigoro, Madiun City, after permission was obtained from the school. Before the measurements started, the researcher prepared the testing location, test equipment, and measurement recording sheets and checked the participant criteria. Before the measurements started, the researcher explained the procedures and methods for each test to all participants.

Data collection was carried out in several stages. Participant identities and measurements of height and body weight were recorded at the beginning of the data collection. Fundamental Movement Skills were then assessed individually using the TGMD-3. After all participants had completed the TGMD-3 assessment, physical fitness was assessed using the TKPN components, consisting of V-Sit and Reach, 60-second Sit-Up, 30-second Squat Thrust, and PACER.

During the field measurements, the results of each test were recorded using the participant's identity to keep the measurement results linked to the correct participant. After completing all measurements, the data were entered into Microsoft Excel. Each participant was then given an identification code, such as P01, P02, P03, and so forth. These codes were used to link the TGMD-3 and TKPN results to the corresponding participant during data processing. The data were then checked for completeness and consistency. The TGMD-3 and TKPN scores were calculated and converted based on the norms of each instrument to determine the FMS proficiency level and physical fitness level categories. The completed and categorized data were used for statistical analysis.



Data Analysis

The TGMD-3 and TKPN measurement data were first calculated and categorized based on the norms of each instrument. Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics were used to present frequency distributions and percentages for categorical variables, along with the mean, standard deviation, minimum, and maximum values for numerical variables.

The FMS proficiency level and physical fitness level were compared using a contingency table (Crosstabs). The Pearson chi-square test was initially considered. However, most cells had an expected *count* of less than 5. The chi-square assumptions were therefore not fulfilled, and the *Fisher-Freeman-Halton exact test* was used instead. This test is used to examine the independence of categorical variables when the sample size is small or the requirements for the chi-square test are not fulfilled (Kim, 2017). A p-value of less than 0.05 was considered statistically significant.

RESULTS

Fundamental Movement Skills Proficiency Level

Based on the measurement results of 27 students using the *Test of Gross Motor Development–Third Edition* (TGMD-3), the *Impaired or delayed* category was the most frequently observed, comprising 10 students (37.0%). Seven students (25.9%) were classified as *Below average*, while another 7 students (25.9%) were in the *Average* category. The *Borderline impaired or delayed* category included 3 students (11.1%). No students were classified as *Above average*, *Superior*, or *Gifted or very advanced*.

Table 3. Distribution of Fundamental Movement Skills Proficiency Levels

FMS Category	Frequency (n)	Percentage (%)
Impaired or delayed	10	37
Borderline impaired or delayed	3	11.1
Below average	7	25.9
Average	7	25.9
Above average	0	0
Superior	0	0
Gifted or very advanced	0	0
Total	27	100

Based on Table 3, 13 students (48.1%) fell into the *Impaired or delayed* and *Borderline impaired or delayed* categories, while 14 students (51.9%) were in the *Below average* and *Average* categories. No students were classified in the *Above average* category or any higher category.



Physical Fitness Level

Based on the measurement results using the Nusantara Student Fitness Test (TKPN), two physical fitness level categories were identified in the study sample, namely *Fair* and *Good*. Of the 27 students analyzed, 14 students (51.9%) were classified as *Fair*, while 13 students (48.1%) were classified as *Good*. No students were classified as *Poor* or *Very poor*.

Table 4. Distribution of Physical Fitness Levels

Physical Fitness Category	Frequency (n)	Percentage (%)
Fair	14	51.9
Good	13	48.1
Poor	0	0
Very poor	0	0
Total	27	100

Based on Table 4, the *Fair* category had a slightly higher proportion than the *Good* category, at 51.9% and 48.1%, respectively.

Relationship Between FMS Proficiency Level and Physical Fitness Level

The relationship between FMS proficiency level and physical fitness level was analyzed using a cross-tabulation (*crosstabulation*). The cross-tabulation results showed that in the *Impaired or delayed* group, 7 students (70.0%) had a *Fair* physical fitness level and 3 students (30.0%) had a *Good* physical fitness level. In the *Borderline impaired or delayed* group, 1 student (33.3%) had a *Fair* physical fitness level and 2 students (66.7%) had a *Good* physical fitness level. In the *Below average* group, 3 students (42.9%) had a *Fair* physical fitness level and 4 students (57.1%) had a *Good* physical fitness level. Meanwhile, in the *Average* group, 3 students (42.9%) had a *Fair* physical fitness level and 4 students (57.1%) had a *Good* physical fitness level.

Table 5. Cross-Tabulation of FMS Proficiency Level and Physical Fitness Level

FMS Proficiency Level	Fair n (%)	Good n (%)	Total
Impaired or delayed	7 (70.0)	3 (30.0)	10
Borderline impaired or delayed	1 (33.3)	2 (66.7)	3
Below average	3 (42.9)	4 (57.1)	7
Average	3 (42.9)	4 (57.1)	7
Total	14 (51.9)	13 (48.1)	27

The expected *count* results showed that 7 of 8 cells (87.5%) had an *expected count* below 5, with a minimum value of 1.44. The Pearson Chi-Square test could not be used because its assumption was not met. The analysis was therefore continued using the *Fisher-Freeman-Halton exact test*, an exact method for evaluating independence in contingency tables when expected frequencies are low (Kim, 2017).

**Table 6.** Fisher-Freeman-Halton Exact Test Results

Statistical Test	Test Statistic	Exact Sig. (2-sided)	Interpretation
Fisher-Freeman-Halton Exact Test	2.287	0.514	Not significant
Note: N = 27; $\alpha = 0.05$.			

Based on Table 6, the *Exact Sig. (2-sided)* value was 0.514, which was above the predetermined significance level of 0.05 ($p > 0.05$). The analysis therefore showed no statistically significant association between Fundamental Movement Skills (FMS) proficiency level and physical fitness level among fourth-grade students at SDN 03 Kanigoro, Madiun City.

DISCUSSION

Among the 27 students assessed, FMS proficiency was distributed across four categories. The largest group was classified as Impaired or delayed, consisting of 10 students (37.0%). The remaining students were classified as Borderline impaired or delayed (3 students, 11.1%), Below average (7 students, 25.9%), and Average (7 students, 25.9%). For physical fitness, 14 students (51.9%) were in the Fair category and 13 students (48.1%) were in the Good category. The Fisher-Freeman-Halton exact test showed no statistically significant association between FMS proficiency level and physical fitness level ($p = 0.514$). In other words, the distribution of physical fitness categories did not show a consistent pattern across the different FMS proficiency categories in this sample.

In this study, 10 students (37.0%) were placed in the Impaired or delayed category, suggesting that optimal FMS proficiency had not yet been achieved by some participants. This result is relevant to physical education, as FMS provides basic movement abilities needed for participation in different physical activities. Liu et al., (2023) reviewed 49 studies and found an association between FMS and several components of health-related fitness, including cardiorespiratory fitness, muscular strength, and muscular endurance. However, the findings across the reviewed studies were not necessarily the same for all fitness components or movement skills. This suggests that the FMS findings in the present study are relevant not only to students' movement abilities but also to aspects of motor development that may need attention during physical education.

Regarding physical fitness, most students were in the *Fair* category, with a similar proportion classified as *Good*. Within the study sample, physical fitness was limited to these two categories, as no students fell into the lower or higher categories according to the TKPN classification. Physical fitness in children may also be influenced by factors other than movement skills. Maia et al., (2024), in a study of 1,014 children aged 6–10 years, found that physical fitness and motor skills were associated with several individual characteristics, although the patterns were not the same for both dimensions. For example, physical activity, age, sex, and body mass index showed different associations with physical fitness and motor



skills. These findings suggest that FMS proficiency and physical fitness represent related aspects of physical development, but they should not be regarded as interchangeable.

The non-significant association found in this study should be considered alongside earlier findings. Behan et al., (2022) reported positive associations between FMS and several components of health-related fitness, including muscular endurance, flexibility, and cardiovascular fitness, in 2,098 elementary school children. Liu et al., (2023) also reported relatively strong evidence for positive associations between FMS and cardiorespiratory fitness, muscular strength, and muscular endurance in their systematic review. However, the different findings do not necessarily indicate a contradiction with previous research. Differences in the characteristics and size of the samples, measurement instruments, and variable categorization may partly explain the different results. Behan et al., (2022), for instance, examined several fitness components separately in a much larger sample, whereas the present study involved 27 students from one school and used FMS proficiency categories and overall physical fitness categories.

Differences in measurement methods may partly explain the association between movement skills and physical fitness, but children's daily physical activities may also be relevant (Panenggak et al., 2022). Children with better FMS may have more opportunities to participate in physical activities, although FMS does not by itself determine how active or fit a child is. Liu et al., (2024) found that the association between FMS and physical activity varied across different activity periods during the school day. For example, some associations were observed during certain recess periods, but similar associations were not consistently observed during other school activities. These findings suggest that movement skills should be considered together with the environment and opportunities for physical activity rather than as the only factor related to physical fitness.

The non-significant result should also be considered in relation to the characteristics of the sample. One participant was 11 years and 4 months old and was interpreted using the highest available TGMD-3 age norm of 10 years 11 months. This should be taken into account when interpreting the FMS results. The study included only 27 students from one school, so the variation in participant characteristics was relatively limited. The FMS categories were also unevenly distributed, with no participants classified as Above average, Superior, or Gifted or very advanced. These characteristics may have limited the ability of the analysis to identify patterns across a wider range of categories. The findings should therefore be viewed as a description of the association between FMS and physical fitness among fourth-grade students at SDN 03 Kanigoro, Madiun City, rather than as evidence that FMS is generally unrelated to physical fitness. Studies with larger samples, participants from multiple schools, and separate consideration of individual fitness components may provide further information about the association between the two variables.

Although the association was not statistically significant, the findings still have relevance for physical education in elementary schools. The presence of students in the Impaired or delayed category suggests that FMS development should remain part of movement-learning activities. Students can be given repeated opportunities to practice locomotor and object-control skills through activities suited to their developmental levels. At the same time, FMS



development should not be considered the only way to improve physical fitness. Physical fitness also requires activities that specifically develop cardiorespiratory endurance, muscular strength and endurance, and other fitness components. Therefore, physical education should give attention to both FMS development and physical fitness rather than focusing on either aspect alone.

CONCLUSION

This study involved 27 fourth-grade students at SDN 03 Kanigoro, Madiun City. FMS proficiency levels varied across the sample, with Impaired or delayed being the most frequently observed category, comprising 10 students (37.0%). For physical fitness, 14 students (51.9%) were classified as Fair and 13 students (48.1%) as Good. The Fisher-Freeman-Halton exact test produced an Exact Sig. (2-sided) value of 0.514 ($p > 0.05$), indicating no statistically significant association between FMS proficiency level and physical fitness level among the students studied.

The results show that differences in FMS proficiency categories were not accompanied by a consistent pattern of differences in physical fitness categories within this sample. This finding should not be interpreted as evidence that FMS is generally unrelated to physical fitness. Rather, it indicates that no statistically significant association was detected under the sample characteristics and measurement methods used in this study. These findings may provide an initial reference for Physical Education learning in elementary schools, particularly for giving attention to both FMS development and physical fitness.

ACKNOWLEDGMENTS

The author would like to express sincere gratitude to the Principal of SDN 03 Kanigoro, Madiun City, and the Physical Education teacher for granting permission, providing support, and assisting in facilitating the research process at the school. Appreciation is also extended to the author's older sister and colleagues who assisted throughout the field data collection process.

FUNDING STATEMENT

This study received no external funding.

CONFLICT OF INTEREST

The author declares no conflict of interest.



REFERENCES

- ACSM's. (2021). *ACSM 11th Edition -- Gary Liguori, PhD, FACSM Senior Editor* - (Vol. 2).
- Ali Maksum. (2018). Metodologi Penelitian: dalam olahraga. In *unesa university press* (Number Juli).
- Bardid, F., Utesch, T., Stodden, D. F., & Lenoir, M. (2021). Developmental perspectives on motor competence and physical fitness in youth. *Scandinavian Journal of Medicine and Science in Sports*, 31(S1), 5–7. <https://doi.org/10.1111/sms.13946>
- Behan, S., Belton, S., Peers, C., O'connor, N. E., & Issartel, J. (2022). Exploring the relationships between fundamental movement skills and health related fitness components in children. *European Journal of Sport Science*, 22(2), 171–181. <https://doi.org/10.1080/17461391.2020.1847201>
- Donnelly, J. E., Ed, D., Co-chair, F., Hillman, C. H., Co-chair, P. D., Ph, D., Etnier, J. L., Ph, D., Lee, S., Ph, D., Tomporowski, P., Ph, D., Lambourne, K., Ph, D., Szabo-reed, A. N., & Ph, D. (2017). Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. In *Medicine and Science in Sports and Exercise* (Vol. 48, Number 6). <https://doi.org/10.1249/MSS.0000000000000901>.Physical
- Kementerian Pemuda dan Olahraga Republik Indonesia. (2022). *Pedoman Tes Kebugaran Jasmani Nusantara (TKPN)*.
- Kim, H.-Y. (2017). Statistical notes for clinical researchers: Chi-squared test and Fisher's exact test. *Restorative Dentistry & Endodontics*, 42(2), 152. <https://doi.org/10.5395/rde.2017.42.2.152>
- Kristiyandaru, A., Al Ardha, M. A., Ristanto, K. O., & Nur, L. (2023). Health Education during the Pandemic: Physical Fitness Course Applications and Personal Physical Fitness Test (PPFT) in University Students. In *International Journal of Education in Mathematics, Science and Technology* (Vol. 11, Number 5, pp. 1275–1292).
- Liu, C., Cao, Y., Zhang, Z., Gao, R., & Qu, G. (2023). Correlation of fundamental movement skills with health-related fitness elements in children and adolescents: A systematic review. *Frontiers in Public Health*, 11. <https://doi.org/10.3389/fpubh.2023.1129258>
- 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*. 1–10.
- Lubans et al. (2012). Fundamental Movement Skills in Children and Adolescents. *Sports Medicine*, 40(12), 1019–1035.
- Magistro, D., Piumatti, G., Carlevaro, F., Sherar, L. B., Eslinger, D. W., Bardaglio, G., Magno, F., Zecca, M., & Musella, G. (2020). Psychometric proprieties of the Test of Gross Motor Development – Third Edition in a large sample of Italian children. *Journal of Science and Medicine in Sport*, 2–7. <https://doi.org/10.1016/j.jsams.2020.02.014>
- Maia, J., Santos, C., & Pereira, S. (2024). *LSU Scholarly Repository A multivariate multilevel approach to unravel the associations between individual and school factors on children 's motor performance in the REACT project*.



- Malambo, C., Nová, A., Clark, C., & Musálek, M. (2022). Associations between Fundamental Movement Skills, Physical Fitness, Motor Competency, Physical Activity, and Executive Functions in Pre-School Age Children: A Systematic Review. *Children*, 9(7). <https://doi.org/10.3390/children9071059>
- Mutohir, T. C., Maksum, A., Kristiyanto, A., & Akbar, R. (2024). Industri Olahraga : Sumber Pertumbuhan Ekonomi Baru. *Disorda.Papua.Go.Id*, 1–125.
- Nur, L., Al Ardha, M. A., Chaeroni, A., Friskawati, G. F., Muslihin, H. Y., Yulianto, A., & Malik, A. A. (2025). Measurement of physical literacy of elementary school students in Indonesia: an analysis using the Rasch model. *Retos*, 65, 909–920. <https://doi.org/10.47197/retos.v65.112957>
- Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity*, 32(1), 1–11. <https://doi.org/10.1038/sj.ijo.0803774>
- Panenggak, N. S. R., Nurhasan, Al Ardha, M. A., Bana, P., Ristanto, K. O., Rizki, A. Z., Utomo, R. S., Yang, C. B., & Lin, W. J. (2022). University Students' Daily Activities and Physical Fitness during COVID-19 Pandemic. *International Journal of Human Movement and Sports Sciences*, 10(2), 166–172. <https://doi.org/10.13189/SAJ.2022.100205>
- Rezigalla, A. A. (2020). Observational Study Designs: Synopsis for Selecting an Appropriate Study Design. *Cureus*, 12(1), 6–10. <https://doi.org/10.7759/cureus.6692>
- Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, 61(3), 261–264. <https://doi.org/10.4103/0019-5154.182410>
- Ulrich. (2019). *TGMD 3rd Edition - 2019.pdf*.
- Wu, H., Eungpinichpong, W., Ruan, H., Zhang, X., & Dong, X. (2021). Relationship between motor fitness, fundamental movement skills, and quality of movement patterns in primary school children. *PLoS ONE*, 16(5 May 2021), 21–24. <https://doi.org/10.1371/journal.pone.0237760>
- Xie, S., Zhou, Y., Yin, Y., Shao, R., Fang, L., & Shao, W. (2023). Effects of fundamental movement skills on health-related quality of life in Chinese school-age children: the mediating role of physical fitness level. *Frontiers in Public Health*, 11(May), 1–9. <https://doi.org/10.3389/fpubh.2023.1023662>
- 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. *Frontiers in Public Health*, 12(January), 1–16. <https://doi.org/10.3389/fpubh.2024.1489141>