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Fundamental Movement Skill (FMS) analysis of young karate athletes

Very Maradona*[1A-E], Tomoliyus[2BC], Endang Rini Sukamti[3BD], Abdul Alim[4E]

[1234]Faculty of Sport Science, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

ABSTRACT

Fundamental Movement Skills (FMS) are critical for youth athletes as the foundation for sport-specific performance and long-term physical development. Karate, as a physically demanding sport, requires strong motor skills such as balance, coordination, and agility. However, current training practices in early-stage athlete programs, such as the Student Achievement Sports Program (POPB), often prioritize technical skills over foundational motor development. This study aims to evaluate the level of FMS mastery in POPB DKI Jakarta karate athletes aged 12–15, providing insight into their motor readiness for advanced training phases. A quantitative descriptive method with a survey approach was used. Data were collected from 31 athletes (19 males, 12 females) through the PLAYfun assessment instrument, which evaluates locomotion, object control, and body management skills. The average FMS score was 73.21, categorized as competent. Athletes showed proficient levels in balance-related tasks, while components like kicking, skipping, and striking were near the lower competent threshold. Female athletes slightly outperformed males in body management skills. The findings indicate that while overall FMS levels are adequate, there is a need for targeted development in specific motor areas, particularly those supporting agility and coordination in karate techniques. The study underscores the necessity of integrating FMS assessments into early athlete training programs. Coaches should adopt individualized training based on FMS profiles and collaborate with multidisciplinary teams. Future research should involve larger samples and technology-based assessments for enhanced accuracy and long-term athlete development planning.

Keywords: Fundamental Movement Skills; Karate; Youth athletes; Motor development; Movement assessment

Corresponding author:

*Very Maradona, Universitas Negeri Yogyakarta, Jl. Colombo No.1 Karangmalang Yogyakarta 55281. Email: verymaradona.2024@student.uny.ac.id

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C) Analysis and interpretation of data;
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INTRODUCTION

Sport plays a crucial role in children's development, particularly in building basic skills that serve as the foundation for future physical activities. One critical aspect of youth athlete development is Fundamental Movement Skill (FMS), which encompasses locomotor, manipulative, and stability skills. FMS not only enables children to participate in various sports disciplines, but also contributes to their long-term health and fitness. In this context, karate, as a form of martial arts, possesses characteristics that demand high physical and psychomotor capabilities, including strength, speed, coordination, balance, and cognitive ability in rapid decision-making. Between the ages of 12 and 15, young athletes are in a vital phase of biological, cognitive, and social development that strongly supports the enhancement of motor skills. A key component in the long-term development of athletic performance at this age is Fundamental Movement Skills (FMS). FMS, covering locomotors (such as running and jumping), manipulative (throwing, catching), and stabilization (balance and postural control), forms the foundation for more complex sport-specific skills (Logan et al., 2015). Numerous studies have stated that insufficient mastery of FMS during childhood can

negatively affect participation in physical activity during adolescence and adulthood (Logan et al., 2012). Therefore, analyzing the level of FMS becomes highly relevant, particularly for young karate athletes who are in a sensitive phase of motor development.

In the context of karate, technical performance is not solely influenced by repetition or technique training, but also heavily depends on the athlete's foundational motor readiness. For instance, techniques such as kicks, punches, and dodges in karate require good hand-eye coordination, core stability, and agility. If FMS are not well developed, an athlete's performance in executing karate techniques may not reach its full potential and may even increase the risk of injury (Arslan et al., 2024). Several studies have demonstrated a strong correlation between FMS mastery and success in martial arts. Alesi et al. (2014) reported that structured karate training over several weeks significantly improved motor coordination, dynamic balance, and self-confidence in children aged 8–12. Moreover, a systematic review by Lorás (2020) emphasized that skill-based sports like karate, when combined with a focus on FMS, are more effective in enhancing executive function and motor control compared to general play-based sports.

This study focuses on athletes aged 12–15 who are part of the Student Achievement Sports Program (Program Olahraga Pelajar Berprestasi, POPB). These athletes are being prepared as the next generation for higher-level competitions. However, empirical data specifically examining the level of FMS mastery among karate athletes in this age group, especially at the early stages of training such as within the POPB program, remains very limited. Without a comprehensive understanding of their basic motor abilities, it is difficult for coaches to design training interventions that are appropriate for both individuals and groups. Conversely, field observations often reveal that early-age karate training tends to emphasize technical and competitive aspects right away, without adequate evaluation of the athletes' fundamental motor readiness. This contradicts the principles of Long-Term Athlete Development (LTAD), which highlight the importance of developing fundamental motor skills before entering the specialization phase (Lloyd et al., 2015). Therefore, scientific research that provides an objective overview of FMS levels in karate athletes aged 12–15 is urgently needed, so that training processes can be more adaptive and evidence-based. Moreover, current developments in motion assessment technology have enabled more accurate FMS evaluation through standardized instruments such as the Test of Gross Motor Development (TGMD-3), Movement Assessment Battery for Children (MABC-2), and biomechanical software. Thus, research that combines quantitative measurement and qualitative observation can offer comprehensive information about the basic motor capacities of young athletes.

The findings of this study are expected to benefit not only POPB athletes but also young athletes more broadly, by providing a foundation for corrective and preventive training programs tailored to each athlete's skill level. This also has the potential to inform national policies on youth athlete development, particularly in advancing sport science based on local potential. Through a structured analysis of FMS, karate coaches can identify each athlete's motor strengths and weaknesses. This step also helps prevent overtraining and ensures that training loads are aligned with the children's physical and motor capacities. Especially during early puberty, children exhibit considerable variation in physical and neurological growth, and training that does not account for this can negatively impact their long-term development (Lloyd et al., 2015). Hence, it is essential for coaches, sports educators, and related institutions to understand that FMS mastery serves not only as an indicator of children's readiness for competitive sports but also as a fundamental pillar for

lifelong physical health. If this aspect is neglected, the potential of athletes may be hindered, both in terms of performance and safety during training.

METHOD

The method used in this research is quantitative descriptive with a survey approach. The researcher collected data directly in the field using the PLAYfun (Physical Literacy Observation for Youth) instrument (Kriellaars & Robillard, 2023). The PLAYfun instrument is accessible through the following website: https://play.physicalliteracy.ca.

Population and sample

The population of this study consists of 570 athletes from the Student Achievement Sports Program (*Program Olahraga Pelajar Berprestasi*, POPB) of DKI Jakarta. The sampling technique used was purposive sampling, with the following inclusion criteria:

1. Belongs to the karate sport discipline
2. Not currently injured
3. Willing to participate in the test

Based on these criteria, the researcher obtained 31 samples for in-depth analysis, consisting of 12 female athletes and 19 male athletes.

Data collection

Data were collected using several instruments, including:

1. Demographic Questionnaire: To gather information regarding age, gender, and sport discipline.
2. FMS Test: The test instrument used to assess the Fundamental Movement Skills (FMS) of the POPB DKI Jakarta karate athletes comprised 18 test items from the PLAYfun assessment series.
    a. *Locomotion*
        1. *Run a Square*
        2. *Run There n Back*
        3. *Run Jump Landing Two Feet*
        4. *Crossover*
        5. *Skip*
        6. *Gallop*
        7. *Hop*
        8. *Jump*
    b. *Object Control Skill*
        1. *Over Hand Throw*
        2. *Strike With Stick*
        3. *1 Hand Catch*
        4. *Hand Dribble stationery Moving Forward*
        5. *Kick*
        6. *Foot Dribble*
        7. *Lift Lower*
    c. *Body Management Skill*
        1. *Balance Walk Forward*
        2. *Balance Walk Backward*
        3. *Drop To The Ground N Get Up*

These items were designed to measure the basic movement skills of the respondents. FMS scores were calculated based on the criteria presented in Table 1 below.

Table 1. FMS test instrument norms

Score Range	Category
1-25	*Initial*
26-50	*Emerging*
51-75	*Competent*
76-100	*Proficient*

Source: (Kriellaars & Robillard, 2023)

RESULTS AND DISCUSSION

Results

This study revealed that the majority of POPB DKI Jakarta karate athletes participating as respondents were male, totaling 19 individuals or 61.29% of the total sample. Meanwhile, female athletes accounted for 12 individuals or 38.71%. This composition reflects a predominance of male participation in karate at the student-athlete level, although female involvement is also relatively significant. These details are presented in Table 2 below.

Table 2. Demographic distribution of respondents by gender (n = 31)

Variable	n	%
Gender		
Male	19	61.29%
Female	12	38.71%

Source: personal data

Additionally, the average age of respondents was 14 years, with the youngest being 12 and the oldest 15. Table 3 shows that the overall mean FMS score among the 31 athletes falls into the competent category (73.21). The highest scores were recorded in the Balance Walk Forward (90.32), Balance Walk Backward (87.10), and Lift and Lower (87.90) components—all of which fall under the proficient category. These results suggest that body stabilization abilities, including static and dynamic balance, have developed well in the majority of athletes. Components such as Overhand Throw and Drop to Ground and Get Up also demonstrated high performance, indicating mature upper body coordination and postural transition ability.

Conversely, the lowest scores were found in the Strike with Stick (61.29) and Skip (62.90) components, both still within the competent category but nearing the lower threshold. This indicates a need to emphasize training in agility and bilateral coordination, which are essential in executing complex karate movement patterns such as punching-step combinations and cross-foot techniques. The Kick component also scored only 65.32, despite kicking being a core element of karate performance, suggesting a need to enhance technique quality through the reinforcement of supporting motor skills.

Table 3. Average FMS scores per component

Variable	Average	Category
Fundamental Movement Sill		

Locomotion		
Run a Square	71.77	Competent
Run There n Back	75.81	Competent
Run Jump Landing Two Feet	63.71	Competent
Crossover	69.35	Competent
Skip	62.90	Competent
Gallop	70.16	Competent
Hop	64.52	Competent
Jump	72.58	Competent
Object Control Skill		
Over Hand Throw	80.65	Proficient
Strike With Stick	61.29	Competent
1 Hand Catch	70.16	Competent
Hand Dribble stationery Moving Forward	72.58	Competent
Kick	65.32	Competent
Foot Dribble	66.94	Competent
Lift Lower	87.90	Proficient
Body Management Skill		
Balance Walk Forward	90.32	Proficient
Balance Walk Backward	87.10	Proficient
Drop To The Ground N Get Up	84.68	Proficient
Average	**73.21**	**Competent**

Source: personal data

Diagram 1 illustrates the comparison of average FMS scores between male and female karate athletes aged 12–15 in the POPB DKI Jakarta program. Overall, both male and female athletes demonstrated performance within the competent category. Female athletes achieved an average FMS score of 75 (competent), an average body management skill score of 75 (proficient), an average locomotion score of 72 (competent), and an object control skill score of 70 (competent). Meanwhile, male athletes recorded an average FMS score of 72 (competent), a body management skill score of 83 (proficient), a locomotion score of 67 (competent), and an object control skill score of 74 (competent).

Although the differences are not substantial, the findings suggest that female athletes in this sample tended to demonstrate slightly higher mastery of fundamental movement skills compared to their male counterparts. This may be attributed to differences in physical and neurological development during early adolescence, as well as potential influences from training programs specific to each group.

Table 4 presents a summary of FMS scores based on three major categories: Body Management Skill, Locomotion, and Object Control Skill. The highest average score was found in the Body Management Skill category, with a mean score of 87 (proficient), reinforcing earlier findings that body control and balance are key strengths among the athletes in this sample. This is particularly important in executing karate techniques, where body stability determines the efficiency of both offensive and defensive actions.

The Locomotion and Object Control Skill categories scored 69 and 72 respectively, both within the competent category. This suggests that aspects such as running, jumping, and object manipulation (e.g., throwing, catching, dribbling) still have room for improvement. These skills are essential for enhancing agility, reaction timing, and spatial awareness during competition. It is recommended that training sessions place additional emphasis on locomotor components such as hop and skip, as well as manipulative skills like strike and catch, to ensure balanced development across all FMS domains.

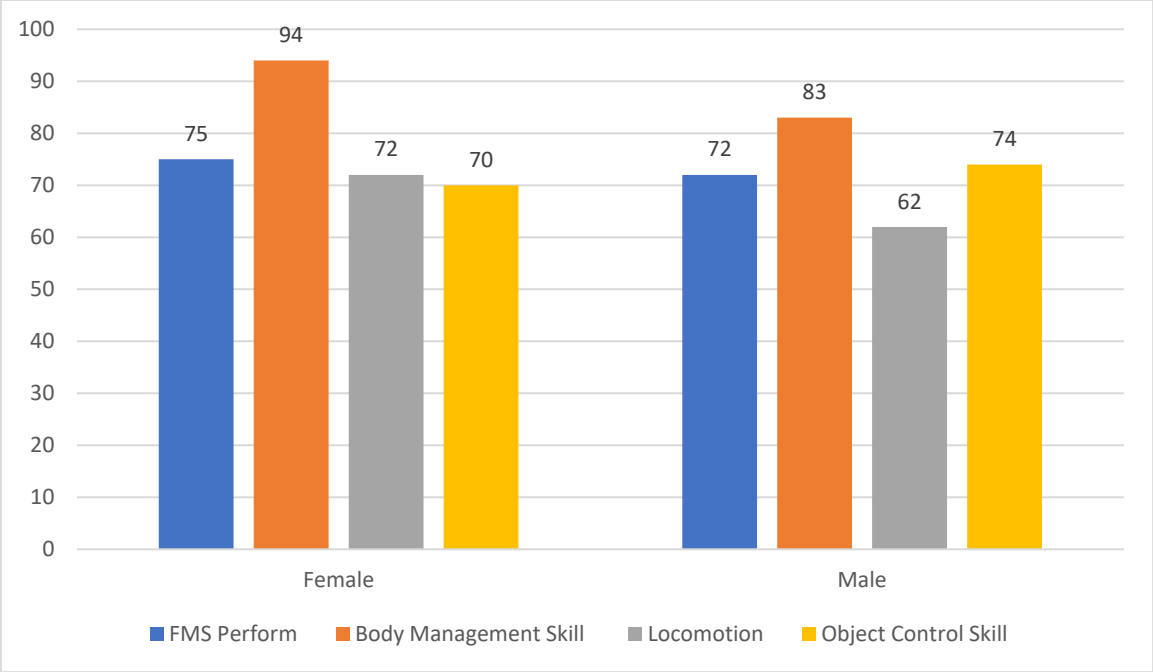

Figure 1. Comparison diagram of average FMS scores between female and male athletes
Source: personal data

Table 4. Distribution of average scores per FMS category

Variable	FMS Perform	Body Management Skill	Locomotion	Object Control Skill
Average	73	87	69	72
Category	Competent	Proficient	Competent	Competent

Source: personal data

Discussion

This study demonstrates that the majority of POPB DKI Jakarta karate athletes aged 12–15 years fall within the competent category across various aspects of Fundamental Movement Skills (FMS), with several components such as overhand throw, balance walk forward/backward, and lift and lower classified as proficient. These findings indicate that, in general, the athletes possess solid foundational motor skills, although not yet fully optimized. This is significant, as FMS are a primary prerequisite for success in mastering sport-specific skills such as karate techniques (Katić et al., 2009). Previous studies have emphasized that early FMS mastery is strongly associated with sustained participation in sports and physical activity (Jones et al., 2020; Xu et al., 2020). In martial arts contexts such as karate, fundamental movement skills not only support technical execution but also influence cognitive aspects such as decision-making and self-confidence in competition (Milazzo et al., 2015). In this study, the high performance in body management aspects such as balance and postural transitions suggests that karate training provides positive stimuli for motor stabilization, an essential component for technique execution and injury prevention.

Deficiencies in FMS, particularly in locomotor and object control components, may increase the risk of injury. Atalay & Atalay (2022) found that children new to karate with low FMS proficiency tend to experience body imbalance while performing basic techniques, potentially resulting in injuries due to uneven biomechanical loading. In the present study, the kick and hop components scoring near the lower limit of the competent

category highlight opportunities for improvement through structured corrective training. Research by Bank et al. (2022) emphasizes that training programs that integrate FMS development and sport-specific technical training simultaneously are more effective in enhancing performance and reducing injury risk. For POPB athletes, such an approach could optimize training outcomes and prolong athletic careers. The findings from this study imply the need for individualized approaches in training programs for young athletes. Variability in FMS abilities among athletes suggests that a uniform training model could lead to undertraining for those with higher capacities and overtraining for those with lower foundational skills. Hence, FMS profiling becomes a crucial tool for coaches to assess athletes' physical readiness before exposing them to high-intensity technical or competitive loads. Overemphasis on early specialization in techniques without strong motor foundations may hinder long-term athletic development. Parker & Labotz (2020) reported that sport specialization before age 15 without sufficient FMS reinforcement increases the risk of burnout and chronic injury. Therefore, training strategies for this age group must strike a balance between learning karate techniques and strengthening fundamental motor skills.

This study also found that FMS distribution was relatively balanced between male and female athletes. However, global research often reports significant gender differences in FMS performance particularly in object control, which tends to be higher among males, and balance, which is more developed among females (Zheng et al., 2022). Males typically have higher muscle mass and testosterone levels, giving them advantages in strength and speed, which aid in mastering movements like running and jumping more rapidly (Bassett et al., 2020). Conversely, females excel in fine motor skills and coordination, especially in balance and body control (Cinar et al., 2023; Jiang et al., 2018). Effective interventions should consider these differences, focusing on strength training for males and balance training for females (Logan et al., 2015). This underscores the importance of gender-based analysis in training program design, enabling coaches to deliver interventions that are both physiologically and psychologically appropriate. In the context of karate, these differences may be less pronounced due to the sport's inherent demand for a balanced combination of strength, coordination, and speed across all athletes, regardless of gender. Nevertheless, training loads must still account for the biological development characteristics of each athlete.

According to Till et al. (2021), Fundamental Movement Skills are not only important for short-term competition readiness but also serve as critical indicators for long-term athlete development (LTAD). Nesbitt & Bullard (2021) state that developing FMS during early athletic life stages paves the way for future development in strength, speed, and more complex technical skills in late adolescence and early adulthood. Therefore, the findings of this study may serve as a foundation for formulating long-term training strategies within POPB and other athletic development institutions. Research by Barker-Ruchti et al. (2018) affirms that countries with athlete development systems based on FMS tend to produce elite athletes with more consistent performance and longer careers. In this regard, it is essential for the Jakarta Provincial Sports Office and the Indonesian National Sports Committee (KONI DKI Jakarta) to adopt FMS as an early indicator in youth athlete selection and in training progress evaluations. With the advancement of biomechanical technology, FMS evaluation can now be conducted more objectively and systematically. Although this study still employed observational methods and standard forms, integration with technologies such as video analysis, motion sensors, or digital TGMD-3 software would improve assessment accuracy and reduce inter-rater bias (Carballo-Fazanes et al., 2021; Kwon & Maeng,

2022). Therefore, training for coaches and sports support personnel in using technological tools should be included as part of strategies to enhance the quality of early athlete development programs.

This study has important implications for youth sports development policies in Indonesia. Training curricula at POPB, PPLM, and PPLP levels should incorporate FMS evaluation and development as standard procedures within training systems. Additionally, these results can promote the development of locally adapted sport science-based training modules that are sensitive to the physiological and socio-cultural conditions of Indonesian athletes. Furthermore, coaches are expected to collaborate with physiotherapists, sport psychologists, and physical trainers in forming multidisciplinary coaching teams capable of comprehensively identifying the specific needs of each athlete. Such collaboration has been proven effective in accelerating performance development and reducing injury rates (Inchauspe et al., 2020). Overall, the results of this study indicate that POPB DKI Jakarta karate athletes aged 12–15 years are at a competent level across various FMS aspects, with several indicators particularly in body management skills reaching the proficient level. These findings underscore the importance of integrating FMS training into youth athlete development curricula. There is a need for individualized training strategies, the adoption of technology in assessment, and the revision of policies grounded in scientific evidence to ensure that athlete potential is developed optimally and sustainably.

CONCLUSION

This study shows that, in general, POPB DKI Jakarta karate athletes aged 12–15 years demonstrate a competent level of mastery in Fundamental Movement Skills (FMS). The highest-scoring components were body management skills such as balance walk forward, balance walk backward, and lift and lower, which were classified as proficient. These results indicate that postural stability and body control are key strengths among the athletes in this sample. Conversely, the lowest scores were observed in the strike with stick, skip, and kick components, which, although still within the competent category, were positioned near the lower threshold highlighting the need for improvement in agility and bilateral coordination. These findings suggest that locomotor and object control aspects warrant greater emphasis in training program design. Additionally, there was a tendency for female athletes to achieve slightly higher average FMS scores than their male counterparts, particularly in body management components. Although the differences were not statistically significant, they underscore the importance of incorporating gender-based considerations in the development of training programs. The findings reaffirm the critical need for systematic integration of FMS training in youth athlete development, particularly before entering the technical specialization phase. Early emphasis on technical aspects without adequate motor readiness poses risks of injury and may hinder long-term development. Therefore, training strategies must be individualized, based on objective FMS assessments, and supported by interdisciplinary collaboration among coaches, physiotherapists, and other support personnel. By strengthening FMS from an early age, youth development programs such as POPB will be able not only produce more competitive athletes but also contribute to the formation of healthy, resilient, and sustainable long-term athletic careers.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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