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Analysis of Injury Risk toward Swimming Athletes based on the Result of Functional Movement Screening

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Abstract

This study aims to analyze the risk of injury in swimming athletes based on the results of Functional Movement Screening (FMS) by considering gender and age group factors. The research method used is a quantitative approach with a descriptive design. The sample in this study consisted of 73 swimming athletes in age groups (KU) 3 and KU 4, aged 10–13 years in Serang City. The sampling technique used was total sampling, so the entire population meeting the criteria was included in this study. The main instrument used is Functional Movement Screening (FMS), which measures the level of stability, mobility, and functional movement quality of athletes as indicators of injury risk. The results showed differences in FMS scores between male and female athletes, where female athletes tended to have lower scores than male athletes, indicating a higher risk of injury. In addition, analysis by age group showed that athletes in the 12–13 years old age group (KU 3) had better average FMS scores compared to athletes aged 10–11 years (KU 4), indicating that with increasing age, the level of movement control and stability increases. These findings underscore the importance of tailored training programs tailored to individual needs, taking into account gender and age, to reduce injury risk in young swimmers.

Keywords: Functional Movement Screening, Injury Risk, Swimmers

INTRODUCTION

Swimming is a sport that is not only healthy but also demands high levels of physical, technical, and mental ability. In each training session, swimmers perform repetitive movements that engage nearly every muscle in the body, from the shoulders and back to the waist and legs. Despite these benefits, there is a significant risk of injury. High-intensity repetition of movements can cause excessive strain on muscles and joints, particularly the shoulders, which are highly susceptible to injury due to repetitive,

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unbalanced movements (Du & Yanai, 2022; Monnet, Samson, Bernard, David, & Lacouture, 2014; Wanivenhaus, Fox, Chaudhury, & Rodeo, 2012; Wolf, Ebinger, Lawler, & Britton, 2009).

One of the most common injuries experienced by swimmers is swimmer's shoulder, an injury that occurs due to overuse of the shoulder muscles without adequate stability and control. These injuries can be caused by weakness of the scapular stabilizer muscles, shoulder muscle imbalances, and even imperfect swimming technique. In addition to the shoulders, the lower back, knees, and ankles are also vulnerable to injury, especially when the body must adapt to less-than-ideal movements (Hibberd & Myers, 2013; Hidalgo-Lozano et al., 2012).

Field research shows that even though swimmers possess good strength and endurance, they are still susceptible to physical problems due to imperfect movement patterns. When the body experiences fatigue or muscle imbalance, movements tend to seek compensation to continue. Unfortunately, this compensation often goes unnoticed, and if it persists, it can lead to long-term injury. When this occurs, the impact not only decreases athlete performance but can also disrupt the continuity of their training (Barry, Lyons, McCreesh, Powell, & Comyns, 2021; Feijen, Struyf, Kuppens, Tate, & Struyf, 2021; McKenzie et al., 2023).

Viewing these conditions, it is important for coaches, athletes, and their parents to focus not only on improving technique and strength, but also on the body's readiness to execute correct movements (Qohhar, Pazriansyah, & Ariani, 2024). One approach that can be used to detect potential movement problems early is Functional Movement Screening (FMS). FMS is a simple assessment method that helps identify weaknesses or stiffness in the body that can lead to injury. With FMS results, coaches and athletes can identify which body parts require more attention and improvement through corrective training (Cook, Burton, Hoogenboom, & Voight, 2014).

To date, FMS has been widely used in several sports, such as soccer, basketball, and track and field. Research in these sports shows that low FMS scores are closely associated with a higher risk of injury (Kiesel, Plisky, & Voight, 2014; Silva, Clemente, Camões, & Bezerra, 2017). However, research linking FMS to injury risk in swimmers is still rare. This is despite the unique characteristics of swimming, unlike other sports with

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predominantly upper-body movements in a water environment, presenting unique challenges and injury risks that require special attention.

Furthermore, swimmers of different ages and skill levels also face varying injury risks. Younger athletes tend to be adapting to techniques and training loads, while older athletes face challenges maintaining performance despite high training intensity. Injuries in both groups can significantly impact their career development. Therefore, the use of FMS can be a valuable tool for mapping potential injury risks and helping to develop more effective prevention programs (Shanley et al., 2011).

This study aims to answer the question of the level of injury risk in swimmers aged 10–13, both male and female, based on FMS results. It is hoped that this research will not only provide an overview of injury potential but also assist coaches and athletes in developing safer, more effective, and more sustainable training programs. With the right approach, athletes can maintain good physical condition, minimize the risk of injury, and continue to develop to achieve top performance in the competition arena.

METHOD

The purpose of this study was to analyze the risk of injury on swimming athletes in Serang City through the results of Functional Movement Screening. This study was designed using a quantitative descriptive method with a survey approach. This method was chosen based on the need to describe the real-world conditions of young swimming athletes in relation to injury risk based on the results of Functional Movement Screening (FMS). Through this descriptive method, researchers can capture a complete and natural picture of what is happening in the field and then interpret it through objective and informative data analysis regarding potential injury risks (McCall et al., 2015). (Dowling, 2013; Koutiva, Gerakopoulou, & Makropoulos, 2016; Sugiyono, 2013) Survey research is research conducted on large or small populations, but the data studied is data from samples drawn from that population, thus identifying the relative incidence, distribution, and relationships between sociological and psychological variables.

This research was conducted in Serang City, Banten. This city was chosen for a reason. The swimming community in Serang City is growing rapidly and is organized, with structured coaching from early childhood through adolescence. Many athletes aged 10 to 13, who are in the Age Group 3 (KU 3) and Age Group 4 (KU 4) phases, will actively participate in local and regional competitions by 2025. This age range is a crucial transition

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period in the development of basic technique, strength, flexibility, and body coordination. At this age, athletes begin to face higher training intensities, but their physical abilities are not yet fully mature, making the risk of injury a significant concern (Clifton, De La Motte, Gribbin, Beutler, & Deuster, 2019; Shanley et al., 2011).

The population in this study was all 73 athletes in the Age Group 3 and 4 swimming groups in Serang City in 2025, aged 10 to 13. To maintain data integrity and obtain a comprehensive picture, the sampling technique used was total sampling. This means that all members of the population who meet the criteria are included as research respondents. This approach ensures that the research results truly reflect the situation faced by all swimmers in that age group, without exception (Budi et al., 2020; Granacher et al., 2016).

Table 1. Number of Swimming Athlete Samples

Category	Age Range	Male	Female	Total
KU 4	10-11	13	34	47
KU 3	12-13	9	17	26
Total		22	51	73

The research instrument used was the Functional Movement Screening (FMS). This measurement tool was chosen because it provides an overview of the quality of fundamental movement patterns, which is crucial for athletes, especially those still developing basic technique and physical strength. The FMS consists of seven main movement sequences (functionalmovement.com, 2018; Syafei et al., 2020).

Table 2. Type of FMS Test

No	Type of FMS Test
1	Deep Squat
2	Hurdle Step
3	In-Line Lunge
4	Shoulder Mobility
5	Active Straight-Leg Raise
6	Trunk Stability Push-Up
7	Rotary Stability

In the Functional Movement Screening (FMS) testing and measurement, each sample performs each FMS movement sequentially, then is given a score of 0-3 according to the FMS scoring system (functionalmovement.com, 2018; Syafei et al., 2020).

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Table 3. FMS Test Score Criteria

No	Criteria	Score
1	Zero is given if the individual has pain during any part of the movement	0
2	One is given if the individual cannot perform the movement pattern even with compensations	1
3	Two is given if the individual can perform the movement but must utilize poor mechanics and compensatory patterns to accomplish the movement	2
4	Three is given if the individual can perform the movement without any compensations according to the established criteria	3

A low score, or less than 14, indicates potential movement dysfunction that can lead to a high risk of injury (Abraham, Sannasi, & Nair, 2015; Bonazza, Smuin, Onks, Silvis, & Dhawan, 2017; Cook, Gray, 2010; Khaleel & Subramanian, 2023; Marques, Medeiros, de Souza, Stigger, Nakamura, & Baroni, 2017; Silva et al., 2017; Syafei et al., 2020; Teyhen et al., 2012).

Before the researcher used study, the FMS instrument was tested for validity and reliability. Studies conducted by (Bonazza et al., 2017; Philp et al., 2018) found that the FMS has excellent validity in detecting movement limitations directly related to injury risk in young athletes. Other studies by Moran, Schneiders, Major, & John Sullivan (2016); Sanchez-Lastra, Moldes, Diz, Martínez-Lemos, & Ayán (2022); Silva, Rodrigues, Clemente, Cancela, & Bezerra (2019); Teyhen et al. (2012) also stated that the FMS has a high reliability of 0.89, with an ICC of 0.86–0.93, indicating consistency of assessments between examiners.

To ensure accurate results, assessments are conducted in a relaxed and conscious environment. Athletes are encouraged to understand that this test is not merely an assessment, but a way for them to understand their own physical condition. This attitude is important so they can go through the process in a relaxed, stress-free manner, so that the results obtained are more honest and reflect their true condition (Zarei, Soltanirad, Kazemi, Hoogenboom, & Hosseinzadeh, 2022).

Through this process, researchers hope to not only obtain numerical data but also provide useful feedback for coaches, athletes, and parents. Knowledge of suboptimal functional movement patterns can provide the foundation for developing more targeted training programs, improving technique, and reducing the potential for future injuries.

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RESULT

1. Distribution of Participants by Age Group and Gender

The following table presents the number of participants by age and gender:

Table 4. Distribution of Participants by Age Group and Gender

Category	Age Range	Male	Female	Total
KU 4	10-11	13	34	47
KU 3	12-13	9	17	26
Total		22	51	73

The majority of participants came from the Grade 4 (10-11 years old) group, with a total of 47 athletes. There were 34 female athletes outnumbering 13 male athletes. Meanwhile, in Grade 3 (12-13 years old), there were also more female athletes than male athletes, with a total of 26 athletes.

1. Functional Movement Screening (FMS) Results Based on Age Group and Gender

Based on the FMS test results, athletes are categorized into three levels of injury risk:

a. Low (Score ≥ 15) The athlete has good mobility and stability, with minimal risk of injury.

b. Moderate (Score 12-14) The athlete has some mobility limitations that could increase the risk of injury.

c. High (Score ≤ 11) The athlete has significant weaknesses in stability or mobility, which have a high potential to lead to injury.

The following is the classification of injury risk based on age group and gender:

Table 5. Injury Risk Distribution by Age Group and Gender

Age	Injury Risk	Male	Female	Total
KU 4 (10-11)	Low	6	12	18
	Medium	5	14	19
	High	2	8	10
KU 3 (12-13)	Low	4	8	12
	Medium	3	7	10
	High	2	2	4
Total		**22**	**51**	**73**

From the table above, several important patterns can be observed: athletes with a high risk of injury were more common in the KU 4 group (10-11 years old), especially female athletes (8 athletes). In KU 3 (12-13 years old), there were fewer high-risk athletes

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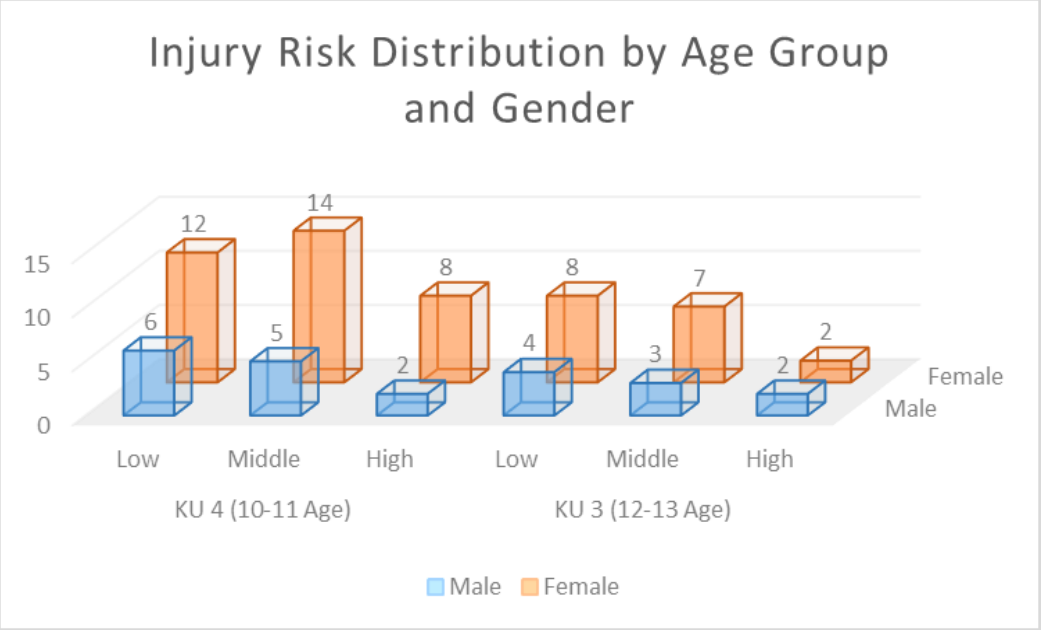
(4 athletes in total), indicating that older athletes tend to have better motor control. Overall, female athletes were at a higher risk of injury than male athletes.

1. Diagram of Injury Risk Distribution by Age Group and Gender

The following is a bar chart depicting the distribution of injury risk by age group and gender:

Gambar 1. Injury Risk Distribution by Age Group and Gender



DISCUSSION

Based on the data analysis conducted, it was found that female athletes have a higher risk of injury than male athletes in the same age group. This finding aligns with research by (Abdullah, Cahyo, & Kinanti, 2020; Anderson, Eumann, & Liven, 2015; Fernández-Galván et al., 2025) which identified differences in sports injury patterns between male and female athletes, particularly in certain sports. These studies indicate that female athletes tend to experience injuries with different severity levels than their male counterparts, possibly due to biomechanical and physiological differences between the sexes.

The results of this study found that KU 4 had 9 athletes in the high-risk category, while KU 3 had 8 athletes. This suggests that younger athletes are more susceptible to movement dysfunction, likely due to a lack of core stability and developing technique (Kennedy, Otley, Hendren, Myers, & Tate, 2024). Furthermore, research by Zein &

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Sudarko (2020) highlighted the importance of evaluating muscle imbalances using the Functional Movement Screen (FMS) in detecting potential injuries in athletes. Although this study focused on sub-elite baseball athletes, the FMS method used can be applied broadly, including in swimming athletes, to assess muscle weakness and imbalances that can increase injury risk.

Furthermore, Rustiawan, Sugiawardana, & Nurzaman (2019) emphasized that the FMS can be used as a tool to measure mobility, balance, and stability in athletes after injury. They suggested the need for further research considering various aspects such as age, gender, and profession of the athlete to ensure the effectiveness of the FMS in various sporting contexts.

In the context of this study, the FMS results showed that female athletes in the 10-11 age group had lower scores than male athletes, indicating a higher risk of injury. This may be due to differences in physical and biomechanical development between boys and girls at that age. Additionally, hormonal factors and differences in body mass distribution can affect stability and mobility, ultimately contributing to an increased risk of injury in young female athletes.

CONCLUSION

The study's conclusion that there are differences in injury risk between male and female athletes within the same age group underscores the importance of a gender-specific approach to injury prevention programs. The use of assessment tools such as the FMS can help identify specific areas requiring increased attention, allowing for the development of effective corrective training programs to reduce injury risk in young swimmers. These findings underscore the importance of tailored training programs tailored to individual needs, taking into account gender and age factors, to reduce injury risk in young swimmers.

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