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Injury Risk Analysis of Soccer Academy Students: A Review of Functional Movement Screen Scores and Demographic Data

Análisis del Riesgo de Lesiones en Estudiantes de la Academia de Fútbol: Una revisión de las puntuaciones de las pruebas de movimiento funcional y los datos demográficos

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Abstract. The intense daily activities of students at the SPSS soccer academy can lead to excessive fatigue, which can decrease physical quality and cause injury. This study aims to analyze the level of injury risk of soccer academy students by reviewing FMS scores and demographic data. This study employed a descriptive observational research method. Research data were collected using tests and measurements. Seventy-two male soccer academy students participated in this study with the following details: mean age 15±2.1 years, BMI 19.8±2.1 kg/m², and TD 1.2±0.1 years. The data were obtained from the FMS instrument and height and weight tests. They were then analyzed using descriptive statistics. The results of the FMS score showed that subjects aged 14-17 years were most at risk of injury in the moderate category. In terms of BMI, the FMS scores showed that subjects at a high risk of injury were one in the underweight category, nine in the normal weight category, and one in the obesity grade 1 category. This study concludes that, based on demographic data, SPSS academy students in the age group of 14 years are more likely to experience injuries than students in the age group of 16 and 17 years. Furthermore, it is concluded that SPSS academy students with an average BMI are in the normal weight category, with SPSS academy student subjects having a moderate risk of injury. Based on the length of training, most SPSS academy students have 1-3 years, with the most risk of injury in the moderate risk category. Future research is expected to choose research subjects with BMI in the obese category and from various other age groups.
Keywords: Sport Injury, FMS, BMI, Training, Soccer Academy, Football, Sports Medicine

Resumen. Las intensas actividades diarias de los estudiantes de la academia de fútbol del SPSS pueden provocar una fatiga excesiva, que puede disminuir la calidad física y causar lesiones. Este estudio pretende analizar el nivel de riesgo de lesión de los alumnos de la academia de fútbol mediante la revisión de las puntuaciones de FMS y los datos demográficos. Este estudio empleó un método de investigación observacional descriptivo. Los datos de la investigación se recogieron mediante pruebas y mediciones. Setenta y dos estudiantes varones de academias de fútbol participaron en este estudio con los siguientes datos: edad media 15±2,1 años, IMC 19,8±2,1 kg/m² y DT 1,2±0,1 años. Los datos se obtuvieron a partir del instrumento FMS y de pruebas de talla y peso. A continuación se analizaron mediante estadísticas descriptivas. Los resultados de la puntuación FMS mostraron que los sujetos de entre 14 y 17 años presentaban un mayor riesgo de lesión en la categoría moderada. En cuanto al IMC, las puntuaciones del FMS mostraron que los sujetos con un alto riesgo de lesión se encontraban uno en la categoría de peso inferior al normal, nueve en la categoría de peso normal y uno en la categoría de obesidad de grado 1. Este estudio concluye que, basándose en los datos demográficos, los alumnos de la academia del SPSS del grupo de edad de 14 años tienen más probabilidades de sufrir lesiones que los alumnos del grupo de edad de 16 y 17 años. Además, se concluye que los estudiantes de la academia SPSS con un IMC medio se encuentran en la categoría de peso normal, teniendo los sujetos estudiantes de la academia SPSS un riesgo moderado de sufrir lesiones. Según la duración del entrenamiento, la mayoría de los estudiantes de la academia de SPSS tienen entre 1 y 3 años, y el mayor riesgo de lesión se encuentra en la categoría de riesgo moderado. Se espera que en futuras investigaciones se elijan sujetos de investigación con IMC en la categoría de obesos y de otros grupos de edad.
Palabras clave: Lesión deportiva, FMS, IMC, Entrenamiento, Academia de fútbol, Fútbol, Medicina deportiva

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Introduction

Soccer is a sport that requires quite complex movements, such as running, jumping, or shooting (De Giorgio et al., 2018; Kokstejn et al., 2019). It is also defined as a multi-faceted sport that combines physical and technical requirements for players to perform at a high level (Anam, Sumartiningsih, et al., 2022; Emmonds et al., 2023). Similarly, other scholars believe that soccer players must have excellent cognitive, perceptual abilities, and motion coordination as these factors will determine the effectiveness of the player's actions (Adelina & Anam, 2023; Bojkowski et al., 2022; Ren et al., 2022). In addition to the basic techniques, physical, and nutritional factors, a player's proficiency in mastering football techniques is also known to significantly affect the player's performance (Guntoro et al., 2020; Rollo & Williams, 2023). A player's proficiency is supported by having excellent body condition (Adelina & Anam, 2023; Azmi & Anam, 2023; Modric & Uljevic, 2022). Many things will happen if a soccer player has a low physical condition, including experiencing obstacles when performing basic soccer techniques. In addition, they will experience fatigue quickly and be prone to injury (Anam, Nurrachmad, et al., 2022; Hrysomallis, 2007; Mucha et al., 2017; Neto et al., 2016; Shitara et al., 2022; Timmins et al., 2016). Sports injuries in soccer are familiar to athletes and

are one thing that is very terrible and haunts their careers (Prianto et al., 2024). This sport has a very high risk of intrinsic injury (Blanchard et al., 2018). In fact, injuries experienced by athletes can reduce the normal work function of physiology and result in permanent disability. Thus, the ultimate impact can be much worse and even end the development of the athlete's career (Hrysomallis, 2013). Each sport also has specific movement patterns that can be used to estimate the risk of injury for athletes (Algaba-Del-Castillo et al., 2023; Irawan et al., 2024). One way to estimate a person's risk of injury is by using the Functional Movement Screen (FMS) (Anam et al., 2024; Cook et al., 2014b; Pfeifer et al., 2019; Ransdell & Murray, 2016).

FMS is a standardized evaluation method used to measure a person's functional movement (Cook et al., 2014a; Ransdell & Murray, 2016). It is intended to evaluate basic movement patterns and find imbalances, weaknesses, or imperfections in functional movements that could be risk factors for injury. FMS can also be used as an evaluation tool that can assist in identifying a person's potential level of injury risk (Abraham et al., 2015; Gibbs et al., 2023; Moore et al., 2019; Syafei et al., 2020). The injury risk levels in FMS are classified as low, moderate, and high injury risk levels (Anam et al., 2024). The FMS evaluates 7 movements and figures out the functional movement patterns. These movements are deep squats, hurdle steps, in line lunges, shoulder mobility, active straight leg raises, trunk stability push-ups, and rotary stability (Cook et al., 2014a, 2014b).

Besides FMS, demographic data can be used to provide valuable insights into injury risk (Kelley et al., 2023; Pollak et al., 2022). The data can provide specific information based on the players' age. For example, certain age groups may have a higher risk of injury than others (Chia et al., 2022; Garcia-Pinillos et al., 2019; Irawan et al., 2024; Pulgar et al., 2021). Demographic data can also show whether certain types of injuries are more common in certain genders or ethnic groups (Beynnon et al., 2014; Stanley et al., 2016; Zech et al., 2022). In addition, Body Mass Index (BMI) is also often associated with children's physical condition, motor coordination, and lifestyle (Andrade-Lara et al., 2024; Felipe et al., 2024; Lopes et al., 2012; Susanto et al., 2023). BMI is also often associated with the incidence of sports injuries (Davis-Wilson et al., 2021; Hartley et al., 2018; Ruiz-Ariza et al., 2021; Toomey et al., 2022).

Risk injury has been an issue for many school academies, such as Safin Pati Sports School (SPSS) soccer academy in Indonesia. Based on their observation, many SPSS academy students still experienced fatigue in daily training. In addition, many SPSS soccer academy students complained about fatigue due to the tight schedule of activities at the SPSS soccer academy, such as learning activities in class. Hence, coaches need to pay attention to preventing student sports injuries by analyzing the risk of injury using FMS. In addition, SPSS football academy students also have diverse demographic characteristics that are yet to be considered.

Although research on the risk of injury in sports has been widely studied by several researchers (Anam et al., 2024; Luiggi & Griffet, 2019; Ransdell & Murray, 2016; Rustiawan et al., 2019), most of the research revolved around high school athletes, colleges, and professional athletes from all sports (Rustiawan et al., 2019). In addition, only a few previous studies have focused on just one sport, such as soccer, especially on soccer academy students. Therefore, the present research was conducted on this issue by predicting the risk of sports injuries in SPSS soccer academy students aged 14 - 16 years. This research used FMS, which was still rarely used by researchers in Indonesia. This method was used to know the level of risk of sports injuries. Based on these statements, this research offers some novelty regarding the sample variety, the variables, and the instruments.

The problems in this study are fundamental since they involved the risk level of sports injuries that may occur in the SPSS football academy. Moreover, the students have pretty dense activities. Otherwise, their injuries will have a negative impact on the student's development and, ultimately, on the progress of the school academy itself. Therefore, this study aims to analyze the injury risk level in SPSS football academy students in terms of FMS scores and student demographic data.

Materials and Methods

Participants

This research involved 72 male students from the SPSS football academy. They were selected using a purposive sampling technique. Inclusion criteria in this study included active students of the SPSS soccer academy, aged 14 - 16 years, not currently injured, and willing to participate in this study. This study excluded students who did not meet the criteria mentioned. Most of the students have trained at the SPSS football academy for 1 year to 3 years.

Research Design

As argued earlier, this study aimed to analyze the injury risk level of soccer academy students by reviewing their FMS scores and demographic data. It employed a descriptive observational research method. This is a quantitative descriptive study that uses tests and measurements to collect data. Prior to data collection, ethical approval for this research was given by the Semarang State University Health Research Ethics Commission with number 217/KEPK/EC/2023. The data were collected using the FMS instrument to predict injury risk. In addition, height and weight tests were used to determine students' Body Mass Index (BMI). The FMS consisted of seven movements, such as deep squats, hurdle steps, inline lunges, shoulder mobility, active straight leg raises, trunk stability push-ups, and rotary stability movements (Cook et al., 2014b, 2014a). The results of height and weight measurements were analyzed to obtain a BMI score using the formula weight (kilograms) divided by height squared (meters) (Nuttall, 2015).

Procedures

This study was attended by all SPSS soccer academy students, who met the inclusion criteria. They were aged between 14 to 16 years. Before the test, the students were briefed on the procedure for collecting data on FMS and BMI scores. They were then given a consent form and a signature of approval to participate. After that, they completed a brief survey and measurement of demographic data, including age, height, weight, and length of training at the SPSS soccer academy.

The research team collected FMS scores individually. The FMS assessment was conducted on all research participants by performing seven movement patterns mentioned in the research design section. After that, ratings were given based on the movements produced by the sample with a score range of 0-3. Participants were rated "0" if the subject failed or there was pain when performing the movement. Participants were then given a score of "1" if the subject could not perform the movement correctly. If the subjects could perform the movement but the movement was assisted using other muscles, they were rated "2". Finally, "3" was given if the movement was perfect. The total FMS score was then calculated by summing up the final score of each movement pattern. The total score can range from 0 to 21.

It is important to note that five movements out of 7 movements in the FMS test measure the presence or absence of asymmetry between the right and left muscles, such as hurdle step, inline lunge, shoulder mobility distance, active straight leg raise, and rotary stability (Cook et al., 2014b, 2014a). Asymmetry is defined as the difference in FMS scores between the body's right and left muscle sides (Davis et al., 2020). If the values generated between the right and left muscles differ, the reported value is the muscle that obtains the smallest value. For example, if the hurdle step movement results in a score of 2 in the right muscle and 1 in the left muscle, the reported score is 1.

Furthermore, FMS scores were analyzed and categorized as low, moderate, and high injury risk levels (Anam et al., 2024). These scoring norm guidelines have been widely used in previous studies (Cook et al., 2014a; Oktarisa et al., 2023; Schneiders et al., 2011), emphasizing the validity of the instrument. If the FMS-defined cutoff score is 14 or below, it indicates a high predicted risk of injury. An FMS score of 15 to 18 indicates a moderate predicted risk of injury. Meanwhile, FMS scores of 19 to 21 indicate a low prediction of injury risk. After determining the level of injury risk, this research also measured students' BMI. The height and weight measurement results were analyzed to obtain BMI scores using the formula weight (kilogram) divided by height squared (meter). Then, the BMI score was assessed using the BMI categories issued by the Ministry of Health of the Republic of Indonesia (P2PTM Kemenkes RI, 2018). The ministry puts the BMI into five categories, namely underweight (<18.5), normal weight (18.5-22.9), overweight (23-24.9), obesity I (25-29.9), and obesity II (≥30).

Statistical Analysis

Data in this study were analyzed using descriptive statistical analysis facilitated by SPSS version 25 and Ms. Excel 2010. The results of data analysis are presented in a graphical form application, the GraphPad Prism version 8.4.0.

Result

The first part of this section provides data about height, weight, BMI score, age, training duration, and FMS score. These data are presented as mean, standard deviation, minimum score, and maximum score, illustrated in Table 1 below.

Table 1.
Descriptive statistics of research data (n=72)

Variable	Mean ± SD	Min.	Max.
Height (cm)	165±6.6	143	179
Weight (kg)	54±8.1	33	74
BMI (kg/m²)	19.8±2.1	16	25.6
Age (years)	15±2.1	14	17
TD (years)	1.2±0.1	0.08	4
FMS (points/21)	18±2.1	11	21

Note. n = Sample Number, SD = Standard Deviation, Min. = Minimum Value, Max. = Maximum Value, TD = Training Duration

After obtaining these data, they were analyzed to determine the FMS based on participants' age, BMI, and training duration. Table 2 provides the results of the FMS score in terms of the demographic data of the research subjects.

Table 2.
FMS score results by Age, BMI, and Training Duration (n=72)

	FMS Categories			
Variable	High Risk n (%)	Moderate Risk n (%)	Low Risk n (%)	Total n (%)
Age				
17 years old	1 (1.38%)	6 (8.33%)	3 (4.16%)	10 (13.88%)
16 years old	4 (5.55%)	17 (23.61%)	10 (13.88%)	31 (43.05%)
14 years old	6 (8.33%)	20 (27.77%)	5 (6.94%)	31 (43.05%)
BMI				
Underweight	1 (1.38%)	16 (22.22%)	7 (9.72%)	24 (33.33%)
Normal	9 (12.5%)	23 (31.94%)	10 (13.88%)	42 (59.15%)
Overweight	0 (0%)	3 (4.16%)	1 (1.38%)	4 (5.55%)
Obesity I	1 (1.38%)	1 (1.38%)	0 (0%)	2 (2.77%)
Obesity II	0 (0%)	0 (0%)	0 (0%)	0 (0%)
TD				
<1 year	3 (4.16%)	12 (16.66%)	7 (9.72%)	22 (30.55%)
1-3 years	8 (11.11%)	31 (43.05%)	11 (15.27%)	50 (69.44%)
>3 years	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Note. n = Sample Number, TD = Training Duration

Based on Table 2, the FMS categories are affected by three categories. Based on their age, it was found that most of participants' were placed at a moderate level of risk. The prevalence of this risk level is always higher across all age groups. Then, the risk was followed by the low and high risks, respectively. However, if we look closer, it can be seen that 14-year-old students have a higher level of injury risk than any other age group. In terms of BMI, nearly all participants in this research had underweight and normal BMI. Interestingly, a lower BMI indicates a lower level of risk of injury. This risk level is higher when the BMI status

increases. For example, participants in the underweight category were mainly classified as low and moderate levels. However, the risk level gradually increased to moderate and high, especially in obesity level I, where all participants in this category were classified within high and moderate levels of risk. Finally, this research provided the effect of training duration on participants' level of injury risk. Table 2 shows that participants' training duration falls into the first two categories: less than one year and 1-3 years. With this duration, more than half had a moderate risk of injury. This figure was then followed by the low-risk and high-risk. The distribution of FMS scores based on age, BMI, and length of training is illustrated in Figures 1-3.

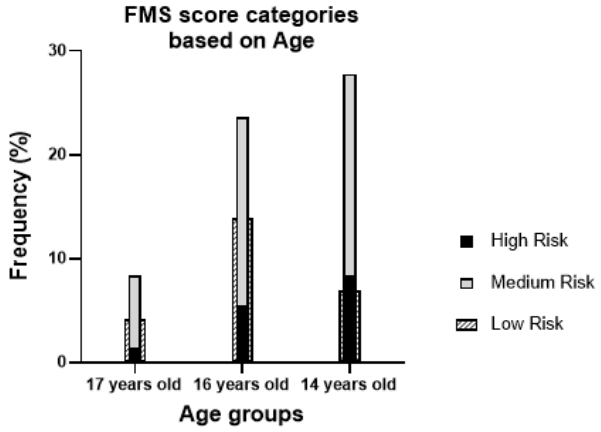

Figure 1. Graphics of frequency distribution of FMS score categories based on age

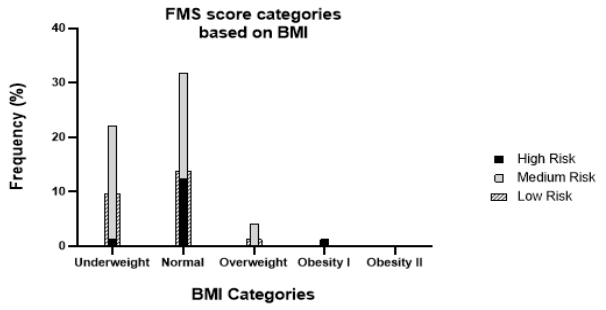

Figure 2. Graphics of frequency distribution of FMS score categories based on BMI

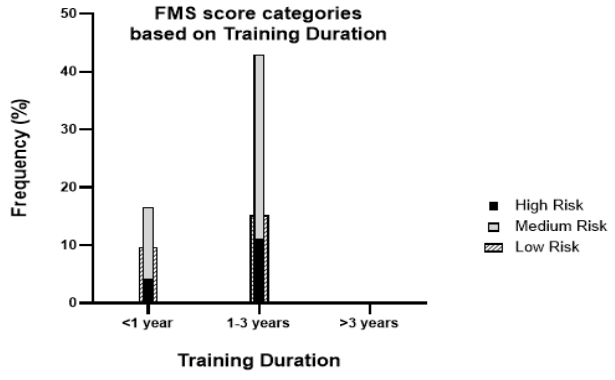

Figure 3. Graphics of frequency distribution of FMS score categories based on Training Duration (TD)

Discussion

This study was conducted using FMS to predict the risk of injury that was likely to occur in the sample. Measurement using FMS aims to measure mobility, flexibility, and body stability movements (Rustiawan et al., 2019). Scholars suggest that lower FMS scores are significantly associated with injury, where scores ≤14 indicate a higher increase in injury risk (Chorba et al., 2010). The test items of the FMS address important motor-related fitness components, one example being balance (Farrell et al., 2021). The FMS has 7 test items: inline lunge, hurdle step, deep squat, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability (Teyhen et al., 2012). Each of these test items has a different objective focus. The seven items combine the upper and lower extremities for efficient bodywork (Pristianto et al., 2018).

The results of the data analysis revealed that SPSS students have a moderate level of injury risk. The sample consisted of 14-year-old, 16-year-old, and 17-year-old students with an overall average FMS score of 18 points. Unlike subjects aged 16 years and 17 years, those who were at the age of 14 years old had a higher level of injury risk, where the average score obtained was 18 points. This figure makes the students fall into the moderate category of injury risk. Meanwhile, the 16-year-old and 17-year-old subjects obtained a score of 19 points, meaning that they fall into the low category of injury risk. This means that the age difference may affect the level of injury risks among students. Strikingly, these findings are not in line with previous research, stating that age does not have a significant influence on FMS values (Abraham et al., 2015).

This study also showed that demographic data are related to BMI. SPSS students had an average BMI that fell into the normal category with a BMI value of 19.8 kg/m² with a standard deviation of 2.1. Based on data analysis, in this study, two subjects were found to be in the obesity I category, where one had a high risk of injury. Research states that FMS scores significantly correlate with BMI (Ünver & Kocaman, 2023). Previous research has also reported that research subjects with normal weight have a total FMS score greater than research subjects with obesity; FMS values will decrease as BMI increases in a person (Mitchell et al., 2016).

Furthermore, the demographic data presents the length of training on FMS. The results showed that students with a training period of 1-3 years had the highest percentage of moderate category injury risk, which reached 43%. This finding confirms previous research that reported a significant difference between athletes with less than nine years of sports experience and athletes with more than nine years of sports experience. The research claims that athletes with more extended sports experience or training periods had higher average FMS scores than those with shorter sports experience or training periods (Ünver & Kocaman, 2023).

Conclusion

This study concludes that SPSS academy students were generally identified as having a moderate level of injury risk. This claim was based on the results of the Functional Movement Screen (FMS) test assessment. More specifically, demographic data of the students show that students in the age group of 14 years are more likely to experience injury than students in the age group of 16 and 17 years. Meanwhile, in terms of BMI, it was found that SPSS academy students with an average BMI were in the normal weight category, with a moderate risk of injury. Based on the length of training, most SPSS academy students have 1-3 years of experience, with the most risk of injury in the moderate risk category. Future research is expected to choose research subjects with BMI in the obese category and from various other age groups. In addition, issues on speed and strength testing can also be explored for further investigation.

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Conflict of interest

There is no conflict of interest in the preparation of this manuscript.

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