

Analysis of injury risk levels in young footballers: A review of functional movement screens and static balance scores

Análisis de los niveles de riesgo de lesión en futbolistas jóvenes: Una revisión de las pantallas de movimiento funcional y las puntuaciones de equilibrio estático

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Abstract: Injury or wound is damage to the structure or function of the body due to physical force or pressure. This study aims to analyze the risk of injury in young footballers in terms of the Functional Movement Screen (FMS) based on static balance scores. This study used a descriptive observational research method. The subjects were 31 young footballers (age 13.6 ± 0.5 years, BMI 19.5 ± 2.2 kg/m², TD 15.5 ± 10 months). The data collection instrument involved FMS and Stand Stork Test (SST). The data were then analyzed using descriptive statistics. This study found that the FMS score with a high injury risk category was 6.45% in the SST poor category. Meanwhile, FMS scores in the moderate injury risk category were 19.35% in the SST moderate category, 32.25% in the SST poor category, and 3.25% in the SST very poor category. FMS scores in the low injury risk category were 6.45% in the moderate SST category and 32.25% in the poor SST category. The conclusion is that SPSS soccer academy students have a potential risk of injury in the moderate category and a static balance level in the less category. In addition, after reviewing the results of FMS scores based on SST scores, it can be concluded that FMS scores in the moderate category are found in samples with poor category SST, which is 32.25%. This study suggests improving static balance to prevent the risk of sports injuries in young footballers. Similar research in the future is also recommended, especially the one that uses other physical component variables and different research sample characteristics.

Keywords: Sport Injury, FMS, Physical Condition, Football, Sport Medicine

Resumen: Una lesión o herida es un daño en la estructura o función del cuerpo debido a una fuerza o presión física. Este estudio pretende analizar el riesgo de lesión en jóvenes futbolistas en función del Functional Movement Screen (FMS) basado en puntuaciones de equilibrio estático. Este estudio utilizó un método de investigación observacional descriptivo. Los sujetos fueron 31 jóvenes futbolistas (edad $13,6 \pm 0,5$ años, IMC $19,5 \pm 2,2$ kg/m², DT $15,5 \pm 10$ meses). El instrumento de recogida de datos fue el FMS y el Stand Stork Test (SST). A continuación, los datos se analizaron mediante estadística descriptiva. Este estudio halló que la puntuación FMS con una categoría de alto riesgo de lesión fue del 6,45% en la categoría mala del SST. Mientras tanto, las puntuaciones FMS en la categoría de riesgo de lesión moderado fueron del 19,35% en la categoría SST moderado, del 32,25% en la categoría SST pobre y del 3,25% en la categoría SST muy pobre. Las puntuaciones FMS en la categoría de bajo riesgo de lesión fueron del 6,45% en la categoría TSM moderada y del 32,25% en la categoría TSM deficiente. La conclusión es que los alumnos de la academia de fútbol SPSS tienen un riesgo potencial de lesión en la categoría moderado y un nivel de equilibrio estático en la categoría menos. Además, tras revisar los resultados de las puntuaciones de FMS en función de las puntuaciones de SST, se puede concluir que las puntuaciones de FMS en la categoría moderada se encuentran en muestras con SST de categoría pobre, lo que supone un 32,25%. Este estudio sugiere mejorar el equilibrio estático para prevenir el riesgo de lesiones deportivas en futbolistas jóvenes. También se recomiendan investigaciones similares en el futuro, especialmente la que utiliza otras variables de componentes físicos y diferentes características de la muestra de investigación.

Palabras clave: Lesión deportiva, FMS, Condición Física, Fútbol, Medicina deportiva

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Introduction

An injury or wound is any damage to the structure or function of the body due to physical force or pressure (Semarayasa, 2014). Scholars argue that injury is caused by many factors which are classified into internal and external factors (Maulana & Anam, 2023; Zein & Sudarko, 2019). If not treated immediately and appropriately, it can cause physical disturbances or limitations in daily activities (Aidar et al., 2022; Oktarisa et al., 2023; Zulhasniati et al., 2024).

Injury usually happens due to accidents or physically demanding activities (Farì et al., 2023). Sports are one example of activities that are prone to injury. A sports injury is an

injury that occurs to the body while a person is exercising. It makes a player or athlete miss a particular match or training session. There are many sports injuries, and they can be grouped based on the place, process, and time of injury. In sports, the injury typically occurs in the muscular and skeletal system of the body. It can cause disability and damage muscles, joints, and other body parts (Timpka et al., 2014). Injuries can reduce the normal work function of physiology and can result in permanent disability (Sudirman et al., 2021). Because it can occur anywhere, for example, during physical education at school or training at a sports club, the injury can affect learning outcomes at school or training outcomes at sports clubs (Latino et al., 2023; Latino &

Tafari, 2023; Mardiyah et al., 2024; Septiantoko et al., 2024). For this reason, certain percentages are made to determine the levels of injuries allowed in body contact sports, including rugby sports at 20%, soccer at 23%, and judo at 2% (Rahmaniar et al., 2019). In soccer, players almost entirely use foot finesse, except for goalkeepers (Bonavolontà et al., 2021; Putri & Anam, 2023). Thus, field players often experience injuries to one of the lower extremity members, which can interfere with daily activities, especially in ankle instability or Chronic ankle instability (CAI) and body's balance (Suhastika et al., 2019).

Understanding the factors that cause injury is necessary to organize an injury prevention program (Attar et al., 2016; Gatterer et al., 2018; Trecroci et al., 2019). One of the efforts to prevent injury is keeping the player's balance. Balance is the ability to adjust the body and physique under various conditions. Some balance functions for the body are beneficial in reducing injuries (Faizullin & Faizullina, 2015). In soccer, balance involves physical, technical, tactical, and mental elements (Fahrurrozi & Anam, 2022). It plays a vital role in soccer games, especially dribbling (Anam et al., 2019; Lisman et al., 2018; Azmi & Anam, 2023; Ragusa et al., 2022). It is one of the basic techniques often used in the games (Deprez et al., 2015; Putri & Anam, 2023). In addition, balance can reduce the impact of injury (Faizullin & Faizullina, 2015; Oběrtinca et al., 2024). As sports that impose high physiological demands, soccer has a high risk of injury due to repetitive high-intensity movements, such as jumping, running, and contact with opponents (Anam, Setiowati, Indardi, Irawan, Aditia et al., 2024). Thus, a good balance can prevent athletes from suffering an injury.

Another factor that reduces the risk of injury is a fit physical condition. Scholars believe that a fit physical condition is needed in soccer games and other sports (Adelina & Anam, 2023; Azmi & Anam, 2023; Bahtra, Tohidin, et al., 2023; Susanto et al., 2023). This condition is obtained through adequate rest, balanced nutrition, and regular sleep patterns (de Sousa et al., 2022; Jorquera-Aguilera et al., 2021; la Torre et al., 2023; Nédélec et al., 2015). If players are feeling unfit, it can be seen in their decreased speed, stamina, and balance. Pratama (2016) emphasized that physical conditions affect football player's performance during the match. Therefore, intensive training is required in all sports to improve players' physical condition or technique (Bahtra et al., 2024; Bahtra, Putra, et al., 2023; Destriani et al., 2024; Irawan et al., 2023; Kurniawan et al., 2024; Latino & Tafuri, 2024; Mulyanti et al., 2024; A. F. Silva et al., 2022).

While injury has become an issue among global athletes, this problem also occurs in young SPSS footballers in Indonesia. A busy schedule of activities, irregular sleep patterns, and an unbalanced diet have seemingly impacted the fitness level of SPSS football players. Eventually, it also affects the achievement of the Safin Pati Sports School SPSS football academy. Some of these crucial problems need to be investigated. To respond to this issue, this study aims to analyze

young footballers' potential risk of injury in Functional Movement Screen (FMS) based on static balance scores.

Actually, several researchers have conducted similar studies (Martín-moya et al., 2023; Šiupšinskas et al., 2019; Wang et al., 2021). However, most of the studies focused on sports injuries in semi-professional and professional athletes. Moreover, the sports investigated in previous studies were individual sports, not team sports (Wang et al., 2021). Therefore, the present research intends to analyze the potential risk of injury in young footballers. To attain the goal, this study used the FMS instrument, which is still rarely used by researchers in Indonesia. This instrument is useful to predict the risk of potential sports injuries. It is a series of functional movements used to assess the risk of movement errors that can cause injury to individuals who exercise or participate in sports activities (Huang & Liu, 2022). This instrument was coupled with a static balance test because the balance component is one of the most critical factors in soccer (Faizullin & Faizullina, 2015; Hrysomallis, 2007). Hence, this study added a static balance test using the stand stork test (SST) instrument. The stand stork test, or what is commonly called a one-leg stand, is a measuring tool that tests an athlete's ability to maintain static balance in a state of standing on one leg (Román et al., 2017; Zumana et al., 2019).

As argued earlier, this study is significant and offers some novelties. The novelty lies in the instrument and the research subject. First, this instrument is still rarely used to determine the potential risk of injury. After that, the sample consists of young footballers from the SPSS football academy. This is different from earlier research that focused on semi or professional players. This research needs to be done to determine the impact of some of the problems on young SPSS footballers. The coach can use the results of this study as evaluation material for the SPSS training program.

Material & methods

Participants

This study involved 31 young footballers from the Safin Pati Sports School (SPSS) academy. They were selected using a purposive sampling technique. The inclusion criteria in this study were young footballers of the SPSS academy who were aged 14 - 16 years, not currently injured, and willing to participate in this study. In addition, most of the study sample had been practicing for one year. This study excluded students who did not meet the stated criteria. The characteristics of samples in this study is described in Table 1.

Table 1.
Demographics of research subjects (n=31)

Variable	Mean \pm SD	Max	Min
Age (year)	13.6 \pm 0.5	14	13
Height (m)	1.6 \pm 0.1	1.8	1.4
Body Weight (kg)	51.2 \pm 8.7	72	33
BMI (kg/m ²)	19.5 \pm 2.2	25.1	16.0
TD (month)	15.5 \pm 10	48	1

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

Research Design

This study employed an observational descriptive research method. It is a quantitative descriptive study that uses tests and measurements to collect data. In particular, the data were collected using the Functional Movement Screen (FMS) instrument to determine the level of injury risk (Bonazza et al., 2017; Morgan et al., 2023). In addition, the Stand Stork Test (SST) was used to measure the level of static balance (Román et al., 2017; Zumana et al., 2019). Before data collection, the Universitas Negeri Semarang Health Research Ethics Commission granted ethical approval for this study with number 211/KEPK/EC/2023.

Procedures

As argued earlier, this study employed two instruments. FMS was used to determine the level of injury risk, while the Stand Stork Test was performed to obtain static balance data. The FMS test was conducted first and individually by a research team of 7 people who already knew the FMS assessment standards. The test was given to all students who had been divided into seven groups. Each group did seven movements, which included 1) deep squat, 2) hurdle step, 3) in-line lunges, 4) shoulder mobility, 5) active leg-raise, 6) trunk stability push-up 7) rotary stability (Pfeifer et al., 2019). This test was carried out on the same day at the same time and was carried out for one day only. In this way, there was no difference in time in data collection. Before the test, students participating in this study were given a consent form. The form also contained a brief survey and demographic data measurements, including age, height, weight, and length of training at the SPSS academy.

The level of injury risk was measured using several movements, while the static balance was measured using only one movement. In FMS, the sample must perform seven movements, including Deep Squat, Hurdle Step, In-Line Lunges, Shoulder Mobility, Active Straight Leg-Raise, Trunk Stability Push-Up, and Rotary Stability (Anam, Setiowati, Indardi, Irawan, Pavlović, et al., 2024; Anam, Setiowati, Nurrachmad, et al., 2024). On the other hand, the Stand Stork Test measured the sample's balance by performing one standing movement. The measurement was done by requesting the samples to lift the heel and try to maintain balance as long as possible. During this action, the student's time in maintaining body position while performing the movement was recorded (Román et al., 2017; Zumana et al., 2019).

The balance test was also carried out individually by the research team, where each researcher was provided a stopwatch to record the time students performed the stand stork test movement. Before conducting the test, students removed their shoes first. Then, the students performed the stand stork test movement with their hands on the hips. Following that, they lifted their heels to balance the balls of their feet and position the foot that does not support the inside of the supporting foot; students lifted the heel of the pedestal foot (Kamarudin et al., 2022). The test was stopped if the student could not maintain the body position.

Once this happened, the researcher recorded the time after stopping.

Table 2.
FMS Scoring Norms

No.	Points FMS	Risk Category
1	≤ 14	High
2	15-18	Moderate
3	19-21	Low

Assessment of the risk of injury using the FMS test was done by multiplying the 7 movements with scoring from 0-3. The scores were then grouped into three categories: low, moderate, and high (Anam, Setiowati, Indardi, Irawan, Pavlović et al., 2024; Anam, Setiowati, & Nurrachmad, 2024; Chang et al., 2020). Table 2 shows that an FMS-defined cutoff point of 14 or below indicates a high injury risk prediction. Meanwhile, values of 15 to 18 indicate a moderate risk prediction. FMS values of 19 to 21 are classified as low injury risk prediction (Farrell et al., 2021).

Table 3.
Stand Stork Test Scoring Norms

No.	Time (sec)	Category
1	>50	Excellent
2	37 - 50	Good
3	14 - 36	Moderate
4	5 - 13	Poor
5	0 - 4	Very poor

Further, Table 3 shows that the assessment balance is categorized into five: excellent, good, moderate, poor, and very poor. The instruments' categories were based on the length of time (in seconds) the samples could maintain their balance. The categories on both instruments were adapted from previous research (Oktarisa et al., 2023; Zulfikar & Bulqini, 2019).

Statistical analysis

The data in this study were analyzed using descriptive statistical analysis facilitated by the SPSS software version 25. The results of data analysis are presented in graphical form, namely GraphPad Prism version 8.4.0.

Results

This section provides research data about the projection of participants' risk of injury and their static balance. It begins by presenting Table 4, which contains descriptive statistics of FMS, including the number of samples, minimum value, maximum value, mean, and standard deviation, and data about static balance (secs).

FMS consists of seven movements. Of these seven movements, it was known that the highest average value was the left hurdle step movement, and the lowest average value was the left rotary stability movement. The deep squat was the only movement with a minimum value of 0, the lowest value of all movements. Three movements had the same average value, namely the suitable hurdle step movement, proper shoulder mobility, and left active straight leg raise, with a value of 2.8. The average total FMS

score was 17.9, with a minimum score of 11 and a maximum score of 20. The standard deviation was 2.1. In the total FMS score, no student scored 21, which is a perfect score. Following that, Table 4 also presents the value of the stand stork test (SST). The test obtained an average of 10.5 seconds, with a minimum value of 3.3 and the highest value of 17.7. The standard deviation was 3.7.

Table 4. Descriptive statistics of research data

Instrument	n	Min	Max	Mean	SD
Deep Squat	31	0	3	2.3	1.1
Hurdle Step	31	2	3	2.9	1.1
In Line Lunge	31	1	3	2.5	1.0
Shoulder Mobility	31	1	3	2.8	1.1
Active Straight Leg Raise	31	2	3	2.8	3.1
Trunk Stability Push Up	31	1	3	2.3	3.2
Rotary Stability	31	1	3	1.9	4.3
FMS score (points/21)	31	11	20	17.9	2.1
SST score (sec)	31	3.3	17.7	10.5	3.7

Note. n= Sample Number, SD = Standard Deviation, Min= Minimum Value, Max= Maximum Value, FMS= Functional Movement Screen, SST= Stand Stork Test

Table 5. Frequency distribution of FMS score and SST score (n= 31)

Points	Category	Frequency	Percentage (%)
FMS score			
≤14	High	2	6.45%
15-18	Moderate	17	54.84%
19-21	Low	12	38.71%
SST score			
>50	Excellent	0	0%
37-50	Good	0	0%
14-36	Moderate	8	25.80%
5-13	Poor	22	70.97%
<4	Very poor	1	3.23%

Note. FMS= Functional Movement Screen, SST= Stand Stork Test

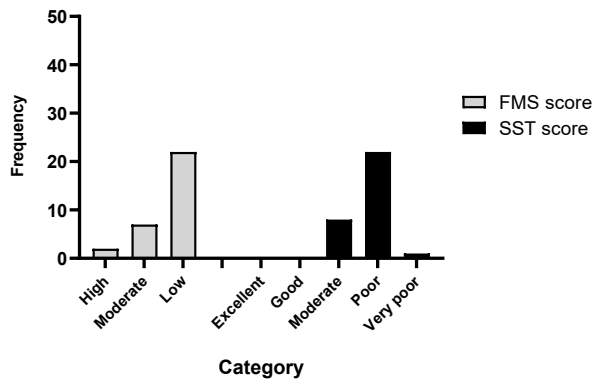


Figure 1. Frequency distribution of FMS score and SST score

Table 5 shows that the FMS score results were dominated by the moderate injury risk category with 54.84%. More than a quarter was placed in the low category and only a few were in a high injury risk category. On the other hand, the static balance scores were dominated by the poor and moderate categories, with 70.97% and 25.80%, respectively. At the same time, the results of the good and excellent categories are 0%. The illustration of the data can be seen in Figure 1 above.

Table 6. FMS score results based on SST score (n=31)

SST Category	FMS Categories		
	High risk n (%)	Moderate risk n (%)	Low risk n (%)
Excellent	0 (0%)	0 (0%)	0 (0%)
Good	0 (0%)	0 (0%)	0 (0%)
Moderate	0 (0%)	6 (19.35%)	2 (6.45%)
Poor	2 (6.45%)	10 (32.25%)	10 (32.25%)
Very poor	0 (0%)	1 (3.25%)	0 (0%)

Note. n= Sample Number, FMS= Functional Movement Screen, SST= Stand Stork Test

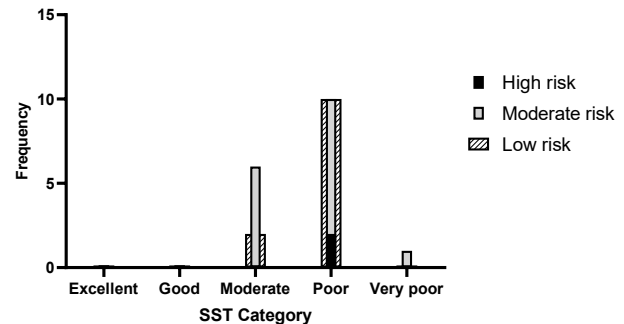


Figure 2. Frequency distribution diagram of FMS score results based on SST score

Table 6 above shows that 6.45% of samples are placed in a high injury risk category and in the SST poor category. Meanwhile, samples in the moderate injury risk category spread in which 19.35% were in the SST moderate category, 32.25% were in the SST poor category, and 3.25% were in the SST very poor category. Finally, samples with the low injury risk category were distributed to the moderate SST category (6.45%) and the poor SST category (32.25%). For more details, the distribution of FMS score results based on SST scores can be seen in Figure 2.

Discussion

Based on the analysis, it was found that the risk of potential injury for SPSS football academy students was categorized as moderate. On the other hand, the SST results were categorized as poor. These findings may result from students struggling to perform one of the FMS movements, rotary stability movements. Hence, the FMS score cannot be maximized. Then, when doing the stand stork test, students could hold their balance at the beginning of the movement. When entering the 7th second, many students lost their balance. After reviewing the results of the FMS score based on the SST score, it can be seen that the results of the FMS score are dominated by the moderate category. On the other hand, samples with SST scores were dominated by the poor category, with 70.97%.

The results of this study confirm previously conducted research that used FMS to describe FMS performance (Smith et al., 2017). The study reported the proportion of

adolescents with scores ≤ 14 and the frequency of asymmetry in cross-sectional samples. In addition, it is in line with the research on using FMS in young footballers (B. Silva et al., 2017). The results of the study describe the FMS score categories to predict injury risk, which is also in line with previous studies (Alemany et al., 2017; Anam, Setiowati, Indardi, Irawan, & Pavlović, 2024; Anam, Setiowati, & Nurrachmad, 2024; Moore et al., 2019; Tondelli et al., 2024). Other scholars also supported this finding by emphasizing the use of FMS and balance tests for screening and predicting injuries (Engquist et al., 2015; Misegades et al., 2020).

Soccer is a high-intensity intermittent sport. Although most of the time is spent walking or running at a low speed, the match is decided by actions performed at higher intensities, such as sprinting, acceleration, tackling, jumping, and dueling (Adelina & Anam, 2023). In soccer games, a fit physical condition is one factor that decides the game and can minimize the occurrence of injuries (Anam & Nurrachmad, 2022; Collins et al., 2021; Mucha et al., 2017; Neto et al., 2016; Shitara et al., 2022; Timmins et al., 2016). If the players are unfit, they can experience sports injuries because soccer greatly involves body contact. The potential to get injured is relatively high (Anam, Sumartiningih, et al., 2022; Putri & Anam, 2023). Unsurprisingly, sports injuries in soccer are familiar and have become one of the things that soccer players do (Prianto et al., 2024).

Soccer has a very high risk of injury (Blanchard et al., 2018). Injuries sustained by athletes can decrease the normal working function of physiology and result in permanent disability. Therefore, the final impact can be much worse and even end the athlete's career development (Biz et al., 2021; Hrysomallis, 2013). Each sport has specific movement patterns that can be used to estimate the risk of injury in athletes (Algaba-Del-Castillo et al., 2023; Irawan et al., 2024). One way to estimate injury risk is to evaluate basic movement patterns and find imbalances, weaknesses, or imperfections in functional movements that can be a risk factor for injury. This can be done using the Functional Movement Screen (FMS) as a standard evaluation method used to measure a person's functional movements (Pavlović et al., 2024; Cook et al., 2014b; Pfeifer et al., 2019; Ransdell & Murray, 2016).

FMS is intended to evaluate basic movement patterns and find imbalances, weaknesses, or imperfections in functional movements that could be a factor in injury. FMS can also be used as an evaluation tool that can help in identifying potential injuries (Alemany et al., 2017; Gibbs et al., 2023; Moore et al., 2019; Ransdell & Murray, 2016; B. Silva et al., 2017; Syaifei et al., 2020). Injury risk levels

in FMS are classified as low, medium, and high injury risk levels (Anam, Setiowati, Indardi, Irawan, Pavlović, et al., 2024). The FMS evaluates seven movements and determines functional movement patterns. These movements are deep squats, hurdle steps, in-line lunges, shoulder mobility, active straight leg raises, torso stability push-ups, and rotary stability (Cook et al., 2014a, 2014b).

Based on the results of this study, it is expected that soccer coaches can screen and test movement asymmetry using FMS, in addition to paying attention to the level of player balance. This is done as an effort to take preventive measures against sports injuries. In addition, the coach can evaluate the training program according to the player's needs after knowing the FMS score and the player's balance level score to minimize injury and improve future achievements. The results of this study can also be helpful information for further research. Future researchers can add other physical condition variables and use samples with different demographic data.

Regardless of its key findings, this study has limitations, including the fact that the sample was limited to the birth of 2009. The SPSS academy has five age groups. This study is also limited to measuring the balance component only, whereas many more components of physical condition can be measured.

Conclusions

Based on the study results, it can be concluded that the level of potential risk of injury in SPSS soccer academy students obtained an average of 17.9. This value indicates that students have a potential risk of injury in the moderate category. Then, a value of 10.5 seconds was obtained at the static balance level, which indicates that students have a static balance level in the poor category. After reviewing the FMS score results based on the SST score, it can be concluded that the results of the FMS score in the moderate category are in the sample with SST in the poor category, which is 32.25%. For this reason, the research suggests improving static balance to prevent the risk of sports injuries in young footballers. The weakness of this study is that the sample was only limited to soccer students with an average age of 13.6 years. This study was also limited to measuring the balance component only, whereas many more components of physical condition can be measured. Future researchers should test other physical condition variables and use samples with different demographic data.

Conflicts of interest

There is no conflict of interest in the publication of this article.

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