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Functional Movement Screen (FMS) as a determinant factor to assess the risk of injuries in young athletes at Jakarta Province, Indonesia

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ABSTRACT

Background: Lower extremity injuries are the most common injuries in young athletes due to running, jumping, sudden change of movement, and contact with the other player in most of the sport's activities. Preventive efforts are the most effective ways to decrease the risk of lower extremity injuries. Functional Movement Screen (FMS) can be considered effective ways in helping to identify risk factors in the young athlete. This study aims to evaluate the FMS as a determinant factor to assess the risk of injuries in young athletes in Jakarta Province, Indonesia.

Methods: Participants were young athletes who train in Provincial Student Sports Training Center (PSSTC), South Jakarta. Athlete age less than 18 years old, agree to participate in this research and has normal physical health will be included in this research and proceed to be asked time exposure of training and history of injuries; body posture and FMS examination. Analysis bivariate dan multivariate were done to see if there is the association of seven components of FMS, sex, time exposure of training, history of injuries, body posture and lower extremity injuries. Data were analyzed using SPSS version 20 for Windows.

Results: There was 87 participant that participated in this research. The data showed that ankle (36.7%), thigh (36.7%) and knee (16.0%) were the three most common lower extremity injuries. Bivariate analysis showed a significant association between *hurdle step*, time exposure of training, and histories of injuries with the incidence of injuries ($p<0.25$). Logistic regression multivariate analysis showed that history of injuries (OR=4.276; 95%CI=1.599-11.437) and time exposure of training (OR=3.470; 95%CI=1.274-9.448) had a significant association with incidence of injuries ($p<0.05$).

Conclusions: There was no association of seven components of FMS with lower extremities injuries. However, there was a significant association of injury histories and training exposure with the incidence of injuries.

Keywords: Functional Movement Screen, Young Athlete, Lower Extremity Injuries.
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INTRODUCTION

In Indonesia, there is an increasing number of young athletes participating in sports competitions. These young athletes also have to train very hard and sometimes beyond their capability. Therefore, young athletes become vulnerable and at risk of injuries.[1] Lower extremity injuries are the most common injuries in young athletes.[1] A study by Sreekarini L et al., showed that 60.1% of injuries of young athletes in India among 461 young athletes 11-19 years old were lower extremity injuries.[2] Fourchet F et al. reported 62.3% lower extremity injuries of 110 young (13-18 year) track and field athletes.[3]

Young athletes' lower extremities injuries were due to running, jumping, sudden movement change, and contact with the other player in most of the sport's activities.[2,3] The other reasons are that young athletes are still in the development stage of their motoric movements, so their mobility, proprioceptive, and coordination movements are poor compared with adult athletes. These will put a young athlete at greater risk of injuries, especially lower extremity injuries.[4]

Prevention is the most effective way to decrease the risk of lower extremity injuries. The preventive actions to lower the risk must train the young athletes on how they should move. Therefore, it is important to analyze how young athletes move. Functional Movement Screen (FMS) can be considered in helping to identify risk factors in the young athlete.[5,6] FMS can identify the ability to move (mobility and stability) based on level of proprioception, flexibility, strength, coordination, balance and neuromuscular control in a young athlete.[5,6] Young athletes with poor functional movement tend to use compensatory movement and create inefficient movement, increasing the load on muscle, bone and joint during activity and cause micro or macro injuries such as apophysitis, sprain, strain, and tendinopathy. Finally, this movement will cause instability during training or competition, increase the risk of contact with the other athlete, and cause injuries.[5,6]

The FMS consists of seven components of functional movements such as shoulder mobility, active straight leg raises, trunk stability push up, rotator stability, deep squat, hurdle step and in-line lunge. Among these seven components, deep squat, hurdle step and in-line lunge are three-component movements believed to contribute dominantly in identifying the risk of lower extremity injuries because these three components specifically evaluate the functional movement of the lower extremity.[5,7] However, research regarding FMS and the risk were lacking and inconclusive.

Based on those mentioned above, this study aims to assess the association of seven movements of FMS, especially deep squat, hurdle step and in-line lunge, with the risk of lower extremity injuries in a young athlete.

Table 1. Socio-demographic features of respondents.

Variable	N=87	Percentage (%)
Sports		
Basketball	15	17.2
Badminton	11	12.6
Soccer	20	23.0
Sepak takraw	20	23.0
Indoor volleyball	13	14.9
Beach volleyball	8	9.2
Gender		
Male	53	60.9
Female	34	39.1
Age (Years)		
≥ 16	59	67.8
< 16	28	32,2
Time of exercise exposure		
Trained	42	48.3
Untrained	45	51.7
Body posture based on NYPRS		
Correct posture	8	9.2
Weak Posture	79	90.8
Body Fat		
Normal	83	95.4
Obese	4	4.6
Previous injury history		
Yes	39	44.8
No	48	55.2

NYPRS: New York Posture Rating Scale

Table 2. The Result of Seven FMS.

Variable	N=87	Percentage (%)
Shoulder Mobility		
Good	68	78.2
Poor	19	21.8
Trunk Stability Push Up		
Good	48	55.2
Poor	39	44.8
Rotator Stability		
Good	37	42.5
Poor	50	57.5
Active Straight Leg Raise		
Good	76	87.4
Poor	11	12.6
Hurdle Step		
Good	14	16.1
Poor	73	83.9
Deep Squat		
Good	66	75.9
Poor	21	24.1
In-Line Lunge		
Good	37	42.5
Poor	50	57.5

METHODS

The study design was a cross sectional study to find an association between the result of seven FMS with lower extremity injuries in young athletes in Provincial Student Sports Training Center (PSSTC), South Jakarta.

Participants were young athletes from basketball, badminton, soccer, sepak takraw, indoor volleyball and beach volleyball who lived and trained in Provincial Student Sports Training Center, South Jakarta. The effect of different sports on the injury was considered minimal because the 6 sports (badminton, indoor volleyball, sand volleyball, sepak takraw, basketball and soccer) selected had a dominant lower extremity injury incidence compared to other limb injuries. All of the athletes were receiving outpatient treatment in sports clinic PSSTC. Inclusion criteria were age less than 18 years old, agree to participate in this research and having normal physical health based on physical examination. Exclusion criteria were unable to finish the research's procedure.

Participants who fulfilled the criteria were instructed to answer the questionnaire (identity, gender, age, time of exercise exposure, previous injury history, past medical history, and history of alcohol consumption) and check body fat percentage using BIA (Bioelectric Impedance Analyzer). Then participants were examined with 90 seconds musculoskeletal examination, body posture examination using Modified New York Posture Rating Scale (NYPRS), physical examination. If the examiner stated that participants had a normal physical examination, participants continued to examine FMS. Participants were instructed to do the seven components movement of FMS such as shoulder mobility, active straight leg raise, trunk stability push up, rotator stability, deep squat, hurdle step and in-line lunge. After examination of FMS, participants were followed for 3 months to see whether there are lower extremity injuries. Lower extremity injuries were checked from the medical record in the sport's clinic PSSTC.

Each of the seven components of FMS was categorized into two classifications: good if the score was 3 and poor if the score was less than 3. Body fat's percentages were normal (less than 20% in males and less than 30% in females) and obese. Time of exercise exposure was categorized into untrained (less or equal with 5 years) and trained (more than 5 years). Previous injury history were lower extremity injuries that happened in the last 6 months before the examination. The modified NYPRS was categorized into an align (if the score was 100) and non-align (if the score was less than 100).

Sample size of 62 participants was calculated for 95% power, α=0.05, estimated proportion at risk is 0.45 and estimated proportion not at risk is 0.2. Chi-square analysis was performed to examine the relationship of seven components of FMS, gender, previous injury history, time of exercise exposure and modified NYPRS with the incidence of lower extremity injuries. If more than one variable has a significant relationship with the incidence of injuries (p<0.25), the variables were further analyzed with logistic regression multivariate analysis using SPSS version 20 for Windows.

RESULTS

There were 87 young participants that participate in this research. Most of the participants were male (67,8%) and more than 16 years old. The data showed that there was not much different proportion between untrained (51,7%) and trained participants (48,3%). Almost all participants had weak body posture (90,8%) and normal body fat's percentage (95,4%). The percentage of participants with a history of lower extremity injuries was relatively high (44,8%) (Table 1).

The results of FMS showed that most of the participants had good results in

Table 3. Incidence and Location of Lower extremity injuries.

Variable	N=87	Percentage (%)
Incidence of injuries		
Injury	30	34.5
No injury	57	65.5
Location of Injuries		
Hip/groin	1	3.3
Thigh	11	36.7
Knee	5	16.7
Lower leg	1	3.3
Ankle	11	36.7
Foot	1	3.3

Table 4. Bivariate Analysis of seven FMS, gender, time of exercise exposure, body posture, previous injury history with lower extremity injuries.

Variable		Injury		Non-injury		p
		N=30	%	N=57	%	
Shoulder mobility	Good	23	33.8	45	66.2	1.000
	Poor	7	36.8	12	63.2	
Trunk stability push up	Good	16	33.3	32	66.7	0.981
	Poor	14	35.9	25	64.1	
Rotator stability	Good	14	37.8	23	62.2	0.735
	Poor	16	32.0	34	68.0	
Active straight leg raises	Good	26	34.2	50	65.8	1.000
	Poor	4	36.4	7	63.6	
Hurdle step	Good	7	50.0	7	50.0	0.224
	Poor	23	31.5	50	68.5	
Deep Squat	Good	25	37.9	41	62.1	0.359
	Poor	5	23.8	16	76.2	
In-Line Lunge	Good	13	35.1	24	64.9	1.000
	Poor	17	34.0	33	66.0	
Gender	Male	14	41.2	20	58.8	0.412
	Female	16	30.2	37	69.8	
Time of exercise exposure	Trained	9	21.4	33	78.6	0.025*
	Untrained	21	46.7	24	53.3	
Body posture	Correct	4	50.0	4	50.0	0.439
	Weak	26	32.9	53	67.1	
Previous injury history	Injury	20	51.3	19	48.7	0.006*
	No Injury	10	20.8	38	79.2	

*Chi-Square: Statistically significant if p-value less than 0.05.

Table 5. The first and second step multivariate analysis of association Hurdle Step, time of exercise exposure and previous injury history with lower extremity injuries.

Variable	Coefficient	p	OR/Exp(B)	95% CI	
				Min	Max
First step					
Hurdle step	-0.501	0.447	0.606	0.166	2.207
Previous injury history	1.417	0.005	4.126	1.536	11.086
Time of exercise exposure	1.203	0.019	3.331	1.217	9.115
Constanta	-1.611	0.037	0.200		
Second step					
Previous injury history	1.453	0.004	4.276	1.599	11.437
Time of exercise exposure	1.244	0.015	3.470	1.274	9.448
Constanta	-2.070	0.000	0.126		

shoulder mobility, active straight leg raise, trunk stability push up, rotator stability and deep squat and poor outcomes in rotator stability, hurdle step and in-line lunge. Active straight leg raises showed the highest proportion of good category among the other FMS. On the contrary, the hurdle step showed the highest proportion of poor category among the other FMS (Table 2). In addition, there were 34.5% of participants injured after three months of follow up. The most common location of injuries was ankle (36.7%), thigh (36.7%) and knee (16.7%) (Table 3).

Bivariate analysis showed that there was no association between all FMS with the incidence of injuries (p>0.25) except for the hurdle step (p=0.224). Among gender, previous injury history, time of exercise exposure and modified NYPRS, previous injury history (p=0.025) and time of exercise exposure (p=0.006) had a significant association with incidence of injuries. Hurdle step, previous injury history and time of exercise exposure were analyzed further with multivariate analysis (Table 4).

In the first multivariate analysis step, the hurdle step didn't significantly affect the incidence of injuries and was excluded from the second multivariate analysis step. In the second step of multivariate analysis, previous injury history (p=0.004) and time of exercise exposure (p=0.015) were significantly associated with the incidence of injuries. Previous injury history had a higher (OR=4.276; 95%CI=1.599-11.437) association with incidence of injuries than the time of exercise exposure (OR=3.470; 95%CI=1.274-9.448). Participants with previous injury history were four times the risk of lower extremity injuries and untrained participants have three times the risk of lower extremity injuries (Table 5).

DISCUSSION

From the socio-demographic data feature, almost all participants had weak body posture. This finding was nearly the same as Solovjova J et al., and Grabara M's research.[8,9] Solovjova J et al., in 2014, researched 92 young athletes 14-17 years old in Latvia and found that almost all athletes had weak body posture, especially in the ankle, pelvis and shoulder.[8] In addition, Grabara M and Hadzik A evaluated young athletes 14-16 years old by comparing body posture between athlete and non-athlete on the same age. The result reported that athletes tend to have asymmetric body posture compared with non-athletes.[9] These body posture problems in athletes were due to muscle imbalance and muscle weakness. They were caused by specific sports training programs, no postural stability exercise, poor movement technique/execution/training, poor postural habit.[10]

The proportion of participants with a history of lower extremity injuries in the last six months was relatively high. Post EG et al. in 2017 found that proportion of young athlete had the previous injury in the last 12 month were 14.7% in the lower extremity and 5.9% in the upper extremity.[11] In addition, Bueno AM et al. in 2018 found that 19.3% of children 7-12 years old that exercise regularly had previous injury history in the last 12 months.[12] Based on these two studies, we can conclude that the proportion of participants with the previous history lower extremity injuries in this research were considered high. The author suspected these phenomena were due to high volume, training intensity, and inadequate recovery time in the training program, so they caused the injury relatively high.

Of seven FMS, the hurdle step had the highest proportion of poor category among the other FMS movements. These results were different from Marques VB et al., who studied 103 young athlete professional soccer players 14-20 years old and found that deep squat had the highest proportion of poor category among the other FMS.[13] These different results may be caused by various training programs that were given by the coach or trainer.

The most common location of injuries in this research was thigh and ankle. This result was almost similar to a study of Fernandez WG et al., where the three most common areas of injuries: ankle, thigh, and knee were found in 4,350 young high school athletes.[14] A previous study also found that school athlete grade 9-12 had lower extremity injuries more frequent in three areas: ankle, thigh, and knee.[11] These phenomena because sports movement always involves running, jumping, kicking, sudden movement change, and uneven surface for training or competition.[13,14]

Bivariate and multivariate analysis showed that seven FMS didn't significantly affect the incidence of lower extremity injuries. This result may be caused by the usage of inappropriate cut off points to determine the poor and good category of FMS movement and didn't evaluate asymmetry movement in the process of FMS's examination. Mokha M et al. in 2016 studied athlete 19 years old National

Collegiate Athletic Association Division II and found that athletes who had FMS' scores equal to one and asymmetry FMS movement will be 2.3 times at risk of injuries.[15] Asymmetric FMS movements mean the different results of FMS score between left and right side of the body on shoulder mobility, rotator stability, active straight leg raise, hurdle step and in-line lunge. The author categorized poor FMS if the score was less than three. This category may need to be modified in poor category FMS if the FMS's score is equal to one because there is a possibility it has a stronger association with the incidence of lower extremity injuries. The author also needs to add evaluation of asymmetry FMS movement in FMS's examination because asymmetry FMS movement has a stronger association with lower extremity injuries. Examination of FMS movement has its weakness such as takes longer time process of FMS's examination, so it will be impractical to be used in the event of screening athlete in a large number. In order to solve this problem, the author suggests checking body posture first before FMS's examination. If the athlete has asymmetry findings, especially on the shoulder or pelvis, the athlete can proceed to FMS's examination.

Previous injury history in this research had a strong association with the incidence of lower extremity injuries. A study by Hagglund M et al., in 2006, evaluated 12 elite's team football in Swedish and found that athletes with a history of hamstring, groin and knee injury had 2-3 times risk of reinjury in the same location on the next season competition.[16] In addition, Kucera KL et al., in 2005, did a prospective cohort study on 7000 athletes 12-18 years old in North California and found that athletes with previous injury history had 2-3 risk of injuries in the future.[17] Risk of injuries were caused by neuroreceptor damage and scar formation due to previous injuries. Neuroreceptor damage will cause disturbance of proprioceptive and functional instability in the joint so that it will put an athlete at greater risk of reinjuries. Scar formation can increase the risk of injury through two mechanisms. First, scar formation can cause disturbance of muscle transmission and coordination of movement, the pattern of movement and muscle strength. Second, scar formation will reduce muscle elasticity and the ability of a muscle to accommodate force when being stretched or pressured. These two mechanism will put muscle at greater risk of strain in the future.[4]

Time of exercise exposure also had a significantly strong association with the incidence of lower extremity injuries in this research. This result was due to different skill levels between trained and untrained participants in training and competition. Peterson L et al., studied 264 male soccer and found an association between age and skill level with injuries.[18] The study found that young athletes with lower skill levels had two times the risk of injuries compared with higher skill's athletes. Chomiak J et al., studied 398 male soccer players and found that athletes with lower skill levels had two times at risk of injuries compared with higher skill athletes.[19]

Other risk factors can affect the incidence of injuries and can cause bias in this research. They are motor skill, impulsive behaviour, knee and foot posture, leg length discrepancy, training program and environment factors (non-optimal lighting, temperature, humidity and uneven surface).[4,20,21]

CONCLUSION

Based on the mentioned above, our study found no association of seven components of FMS with lower extremities injuries. This result may be caused by the usage of inappropriate cut off points to determine the poor and good category of FMS movement and didn't evaluate asymmetry movement in the process of FMS's examination.

CONFLICT OF INTEREST

There is no competing interest regarding the manuscript.

ETHICAL CONSIDERATION

This study was approved by the Ethics Committee of the Medical Faculty of Universitas Indonesia, Jakarta, with the number KET-779/UN2.F1/ETIK/PPM.00.02/2019. All participant gave their written informed consent and assent before data collection.

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AUTHOR CONTRIBUTION

All of the authors equally contributed to the study from the conceptual framework, data gathering until reporting the study results.

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