



The Association Between Landing Error Scoring System and Lower Extremity Injuries in Pusat Pelatihan Olahraga Pelajar Dki Jakarta

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Abstract

Background: Student-athletes who are still experiencing physical and psychological growth and developmentally immature are prone to getting sports injuries. Landing Error Scoring System (LESS) is a screening tool to assess the risk of injury to determine the movement error of jumping and landing.

Objectives: The purpose of this study was to find the scientific evidence regarding the role of LESS concerning lower extremity injuries.

Methods: This cross-sectional study involving eighty-seven participants from six sports divisions at the Pusat Pelatihan Olahraga Pelajar (PPOP) DKI Jakarta. The participants performed history taking, physical examination, and jump-landing tasks using LESS analysis. Participants will be monitored for three months to determine the lower extremity injuries event. In addition to the results of LESS, gender, history of previous injuries in the last six months, and body posture alignment will also be analyzed in conjunction with lower extremity injuries using SPSS v.20.0 software.

Results: The average of 16-year-old participants with boys more than girls (60.9%). LESS result, gender and body posture alignment did not show a significant association with lower extremity injuries ($P > 0.05$). History of previous injuries in the last six months and duration of training less than five years had a significant relationship with lower extremity injuries ($P < 0.01$ and $P < 0.05$).

Conclusions: The application of the LESS test for assessing the risk of lower extremity injuries in athletes of PPOP needs further research. Because lower extremity injuries may be due to other risk factors such as a history of previous injuries and the duration of the training, the more in-depth pre-participation examination of athletes for injury risk factor screening is needed.

Keywords: Landing Error Scoring System, Lower Extremity Injuries, Student-Athletes, PPOP DKI Jakarta

1. Background

There has been increased participation in exercise or sport by young people in Indonesia nowadays. It can reduce stress, prevents several chronic diseases, improves health-related fitness, the quality of sleep, and self-confidence significantly (1). However, participation in exercise or sport can also increase the risk of sports injury (2). According to the National Institute of Arthritis and Musculoskeletal and Skin Diseases, musculoskeletal injuries were the most common reason for injury-related visits to primary care physicians (3).

Several factors can cause sports-musculoskeletal injuries for young people. Young people's bodies are still in the growing phase (because of an epiphysial plate on their bones), which are prone to injury. Psychological immatu-

riety in youth also contributes to increasing the risk of musculoskeletal injuries (2, 4). Young athletes in Pusat Pelatihan Olahraga Pelajar DKI Jakarta (PPOP) train almost every day for several hours, which makes them vulnerable to becoming injured. Habelt et al. (2011) reported that 4468 athletes aged between 10-19 years old were treated for sports-related musculoskeletal injuries, and the lower extremity was involved in 68.71% of the cases (5).

Clinical assessment tools are needed to identify the problems in the musculoskeletal system that may lead to injury. The landing error scoring system (LESS) is a valid and reliable clinical assessment tool that can identify individuals who are at high risk of injury by evaluating changes in the jump-landing technique (6, 7). According to the author's knowledge, there is no research study about the relationship between LESS and lower extremity injury on the

young athlete population in Indonesia.

2. Objectives

The present study aims to know and find the relationship between LESS and lower extremity injuries on young athletes in Indonesia.

3. Methods

3.1. Participants

Eighty-seven healthy youth athletes (53 boys, 29 girls, aged 13 - 17 years) from six sports divisions (badminton, indoor volleyball, beach volleyball, basketball, sepak takraw, and soccer) were recruited. The study participants came from a cluster sample. All participants were trained at least five days per week. Participants with illnesses or musculoskeletal injury at the time of testing were excluded from this study.

3.2. Design and Test Procedures

The study protocol and design were approved by the ethics committee of the faculty of medicine, Universitas Indonesia. A cross-sectional study was conducted in July 2019 for this study. Before the test, the researcher explained all test procedures and the risk of the test to the participants. All participants made history taking and general physical examination by a researcher or assistant. The significant components of history-taking were age, gender, sports division, duration of the training, and history of the previous injury. Vital sign, body weight, and body fat percentages were measured using bioelectrical impedance analysis (Omron HBF-375 Karada Scan Body Composition Monitor). The postural alignment was observed and recorded using the postural grid from the Android mobile application (ACPP Core 2). All the participants did the jump-landing task using a landing error scoring system. The researcher would follow up with the participants about three months looking for lower extremity injury.

3.3. Landing Error Scoring System Protocol

Participants were instructed to jump forward from a 30-cm box to a distance of 50% of their height away from the box and land with both feet. After landing, they should rebound for a maximal vertical jump. Participants were given two practice trials and one test trial. One DSLR camera (Fuji Film XA-3) was placed anteriorly, and one video camera (Sony H.D.) was placed laterally to capture both frontal and sagittal views of the jump-landing task. There are 17 items with a total score of 19. The final LESS score is calculated by totaling the number of errors observed by

the researcher. A cut-off of 5 for the LESS score was used to determine whether the participant had a good jump-landing movement ($LESS < 5$) or a poor ($LESS \geq 5$) score.

3.4. Statistical Analysis

Nonparametric methods were applied for most of the variables (except age) because of the abnormal distribution as assessed by the Kolmogorov Smirnov test. Comparisons between several participant characteristics (gender, postural alignment, duration of the training, history of the previous injury, LESS score), and lower extremity injury were analyzed using the chi-square and Fisher test. Logistic regression in multivariate analysis was used to examine the relationship between several participant characteristics and lower extremity injury, which had a significant result ($P < 0.05$). Data analysis was performed using SPSS version 20.0 (IBM Corporation, Armonk, NY, USA).

4. Results

All of the participants were evaluated for inclusion in the study. The mean age was 15.89 ± 1.083 years. Regarding gender, girls were less than boys. The sports division, which had a large number of participants are soccer and sepak takraw (Figure 1). The proportion between trained and untrained participants according to the duration of training was similar. More than eighty percent of the participants had a non-aligned posture. The proportion of participants who trained for more than 5 years and below five years are identical. The proportion of participants who had a history of previous injury was quite significant (Table 1). Lower extremity injuries were found in one of the third of the participants. The most commonly injured site was the thigh (11 cases, 36.7%) and ankle (11 cases, 36.7%) (Table 2).

We did not find a significant correlation between gender and the tendency of getting lower extremity injuries ($P > 0.05$) (Table 3). Regarding postural body alignment, both align, and non-aligned postures did not show differences in the tendency of getting lower extremity injuries ($P = 0.439$) (Table 3). The untrained participants tended to suffer lower extremity injuries more than the trained ones and were statistically significant ($P = 0.013$) (Table 3). Participants who had a history of previous injuries (in the past six months) tended to have lower extremity injuries more than the participants without a history of previous injuries ($P = 0.003$) (Table 3). Participants with good LESS scores were proportionately more than poor LESS scores. Still, the result of this study showed that an excellent LESS score appeared to have more lower extremity injuries events, although not statistically significant ($P = 0.566$) (Table 3).

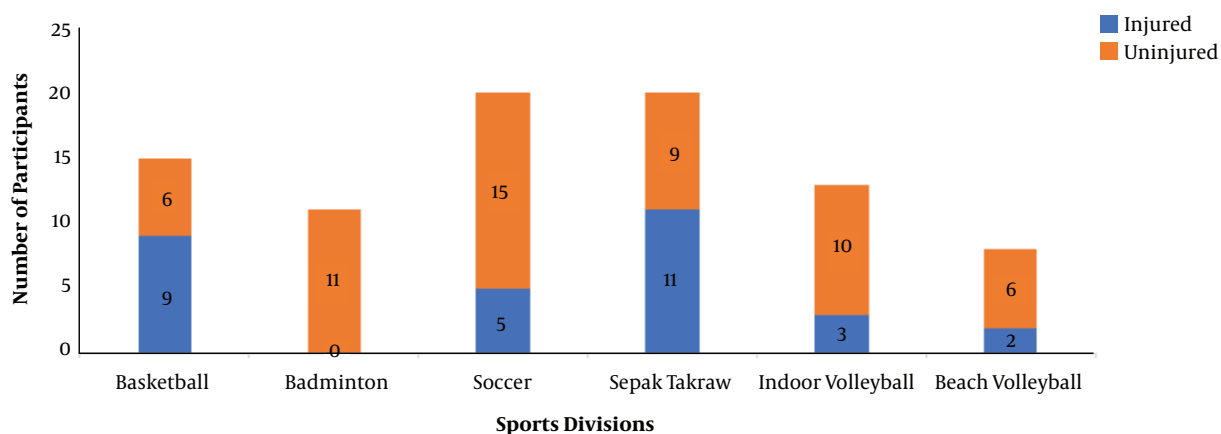


Figure 1. Distribution of lower extremity injuries according to sports divisions

Table 1. Characteristics of Participants

	Mean \pm SD or No. (%)
Gender	
Boy	53 (60.9)
Girl	34 (39.1)
Age	
≥ 16 years old	59 (68)
< 16 years old	28 (32)
Body postural alignment	
Aligned	8 (9.2)
Non-aligned	79 (90.8)
Body fat percentage	
Normal	83 (95.4)
Overweight	4 (4.6)
Duration of training	
Trained	42 (48.3)
Untrained	45 (51.7)
History of previous injury	
Yes	39 (44.8)
No	48 (55.2)

4.1. Multivariate Analysis

According to the assessment of several participant characteristics, duration of training, and history of previous injuries were two components that had a significant association to lower extremity injuries, and they were included in multivariate analysis. The results show that the history of previous injuries has a stronger relationship, which means had a more significant risk for getting lower

Table 2. Anatomical Distribution of Lower Extremity Injuries

Anatomical Distribution	No. (%)
Hip dan Groin	1 (3.4)
Upper leg	11 (36.7)
Knee	5 (16.7)
Lower leg	1 (3.4)
Ankle	11 (36.7)
Foot	1 (3.4)
Total	30 (100)

extremity injuries at participants in this study (Table 4).

5. Discussion

The proportion of lower extremity injuries in boys did not differ significantly from girls. Baumhauer et al. (1995) also found no differences in the number of ankle sprain injuries in soccer, lacrosse, and hockey between both genders (7).

About thirty-four percent of participants in this study suffered lower extremity injuries, especially in sepak takraw, soccer, and basketball. The thigh and the ankle were the most common lower extremity injury locations found in the participants. These results were consistent with a retrospective cohort study conducted by Renshaw and Goodwin, which showed that the thigh was the most common site of lower extremity injuries in young athletes in the English Premier League football (8). Elke et al. (2007) suggested that the ankle sprain was the most often injuries that occur in basketball athletes (9). Borowski et al. also found that the ankle was the most common site of injury

Table 3. Association Between Participants Characteristics and Lower Extremity Injuries

Characteristics	Injured, No. (%)	Uninjured, No. (%)	Total	P Value
Gender				
Boys	16 (30.2)	37 (69.8)	53	0.293 ^a
Girls	14 (41.2)	20 (58.8)	34	
Body postural				
Aligned	4 (50)	4 (50)	8	0.439 ^b
Non-aligned	26 (32.9)	53 (67.1)	79	
Duration of training				
Trained	9 (21.4)	33 (78.6)	42	0.013 ^a
Untrained	21 (46.7)	24 (53.3)	45	
History of previous injuries				
Yes	20 (51.3)	19 (48.7)	39	0.003 ^a
No	10 (20.8)	38 (79.2)	48	
LESS score				
Poor	5 (26.3)	14 (73.7)	19	0.566 ^a
Good	25 (36.8)	43 (63.2)	68	

^aChi-square test^bFisher test**Table 4.** Logistic Regression Multivariate Analysis for Lower Extremity Injuries

Variable	B	S.E.	OR	P Value	CI 95%	
					Min	Max
1. History of Previous Injuries	1.453	0.502	4.276	0.004*	1.599	11.437
2. Duration of Training	1.244	0.511	3.470	0.015	1.274	9.448
3. Constant	-0.627	0.411	0.534	0.127		

experienced by basketball athletes in the United States in 2005 - 2007 (10). The retrospective study conducted by Miranda et al. also reported that the ankle was the most common site of injury to the lower extremities in young athletes' indoor volleyball in Puerto Rico and Brazil, both in boys and girls (11).

Soccer athletes often make a sprint to catch or dribble the ball. Thigh injury may occur in the phase of the late swing and late stance due to excessive eccentric contraction on the hamstring (12). The six sports divisions mostly involved jump-landing movement. The ankle is a joint where the lower leg and foot meet, receive an enormous body burden and have thin ligaments in maintaining the stability of the ankle joint. Plantarflexion and inversion during landing caused overstretching of the anterior talofibular ligament (ATFL), causing the lateral ankle sprains (13).

The association between body posture and the risk of lower extremity injury is still controversial. Cowan et al.

(1996) suggested that an increasing Q angle in basketball athletes will increase the risk of ACL injuries (14). However, Soderman et al. (2001) showed no association between the Q angle and the incidence of lower extremity injuries in soccer athletes (14). Miligrom et al. (1991) reported no association between the incidence of varus knee and lower extremity injuries. Meanwhile, Wen et al. (1998) suggested that varus knee increased the rate of lower extremity injuries (esp. shin splints) in runners (14). Low arch morphology of the foot causes an abnormal alignment of the body and increased the load on the medial side of the foot when on the floor. Giladi et al. (1987) found that athletes with high-arch foot increased the risk of a stress fracture of the tibia, femur, and foot compared to athletes with low-arch foot (14). These results did not show consistency with research conducted by Beynon et al. (2001), which stated that there was no association between the morphology of the foot and lower extremity injuries (15). Controversial results obtained from these studies may be due to differences

in the definition of operational injury used, the lack of consistency among researchers in assessing posture, or differences in the methods used to determine the alignment of the body.

Padua et al. demonstrated that LESS has good validity, inter-rater, and intrarater reliability in assessing an individual jump-landing movement (6). Mechanical movement jump-landing with a cut-off score of $LESS \geq 5$ (motion-jump landing unfavorable) will increase the burden on lower extremity joints so that the risk of injury, especially anterior cruciate ligament (ACL) injury increased. Sagittal plane motion stiffness during landing (less degree of trunk, hip or knee flexion), excessive hip adduction, excessive movement of the frontal plane (knee valgus), or an increase in hip and knee rotation are the example of abnormal landing movement techniques (16). In contrast with the study above, the results of this study indicate that the LESS score did not have a significant association with lower extremity injury. Differences found in this study are caused by differences in injury definitions used compared to previous studies. Differences in the sports division, levels of competition, or environmental factors (temperature and humidity) observed between the studies may also give different results.

The duration of training had a significant association with lower extremity injuries ($P < 0.05$). Lower extremity injuries occur mostly in participants who trained \leq five years. One prospective cohort study by van Beijsterveldt et al. compared the incidence and characteristics of the injured amateur and professional soccer athletes for one season (2009 - 2010) in the Netherlands. The study found that as many as 274 of 456 (60.1%) amateur soccer athletes and 136 of 217 (62.7%) professional soccer athletes got sports injuries. Professional athletes tend to experience mild injuries, while amateur athletes tend to experience moderate to severe injuries ($P < 0.001$) (17). The tendency of sports injuries is more common in untrained subjects, which can be caused by a tendency of lack of experience in dealing with the game situation, including the participant's psychology, who is still immature. However, this result was not consistent with studies conducted by Hersero et al. (2014) and Hammes et al. (2015), who found that the incidence of injuries in amateur athletes is lower than professional athletes (18). Professional athletes who have been training for a long time have more exposure to the risk of injury that causes sports injuries to a higher amount than amateur athletes. Post et al. (2017), in a case-control study, suggested that athletes who trained and competed in the single-specialization sport for more than eight months of the year tend to be 1.66 times more likely to report lower extremity overuse injuries than athletes who trained below eight months ($P = 0.001$). Besides, athletes who partici-

pated in the single-specialization sport for more hours per week than their age (i.e., a 16-year-old athlete who participated in his or her primary sport for more than 16 h/wk) were more likely to report an injury of any type ($P = 0.001$) (19). These inconsistent results of the studies require further research.

The previous history of lower extremity injuries in the last six months have a significant relationship with the lower extremity injury. The results of the study are consistent with Surve et al., who reported the increase in the number of ankle injuries in athletes with a history of previous ankle injury compared to athletes who had no history of injury (20). Study Orchard et al. (2001) investigated the association between a history of injury and the incidence of lower extremity muscle strains in Australian football athletes. The study showed that participants who had a muscle injury in the past 8 weeks increased the risk of injury in the same site (21). Systematic studies reviewed by McCall et al. stated that five of six studies showed that a history of previous lower extremity injuries was associated with the incidence of lower extremity injuries (21). Proprioception is a sense related to the position and movement of the body, which is generated by the mechanoreceptors located in the joints, muscles, tendons, and skin. Musculoskeletal injuries can impair proprioception. Therefore the risk of injury to the lower extremities will be increased.

5.1. Conclusion

The landing error scoring system (LESS) found no association with lower extremity injuries in PPOP DKI Jakarta's athletes. The application of the LESS test for assessing the risk of lower extremity injuries in athletes of PPOP needs further research.

Footnotes

Authors' Contribution: Study concept and design: N and J.K.; analysis and interpretation of data: N, J.K, and T.P.; drafting of the manuscript: N and T.P.; critical revision of the manuscript for important intellectual content: N, J.K. and T. P.; statistical analysis: N.

Conflict of Interests: There is no conflict of interest in this study.

Ethical Approval: Participation in the survey was voluntary, and anonymity and confidentiality were assured. Only subjects who received written consent from their teachers and agreed to participate were recruited. The study was approved by the local ethical committee (the Ethics Committee of the Faculty of Medicine University of Indonesia) with a number of protocols: 19-07-0810, date 08 Jul 2019.

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