LANDING ERROR SCORING SYSTEM FOR SCREENING RISK SCORES BETWEEN MALE AND FEMALE IN UNIVERSITY STUDENTS

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ABSTRACT

Background: The lower extremity is the location of the highest injury incidence rate in sporting injuries and there may be a difference in the type of injury sustained between genders. The injuries affect loss of playing time and are in some cases expensive to treat, or rehabilitate. Therefore, screening for risk factors is an important consideration in injury prevention. **Purpose:** The purpose of this study was to compare the scores of the Landing Error Scoring System test (LESS) between male and female University students. **Method:** Thirteen males (age; 19.5 ± 0.7 years, body weight; 59.5 ± 2.9 kg, height; 166.6 ± 2.9 cm) and fourteen females (age; 19.5 ± 0.8 years, body weight; 58.8 ± 3.8 kg, height; 166.1 ± 3.2 cm) participants completed the LESS. Data were recorded using two video cameras (300 frame per sec) in both sagittal and frontal planes, the subjects practice 2 trials and subjects show their performance of 3 successful trials of the jump-landing task. Then, motion analysis used 2 plane video recorded analysis by LESS score sheet and statistical analyzed using either an independent sample t-test to compare the differences in test scores between genders. The α was set at $p < 0.05$. **Results:** The LESS score was significantly lower in males compared with females (Males; 4.81 ± 1.52, Females; 6.11 ± 1.73, respectively; $p = 0.050$). The four level of LESS score no significant difference, the excellent (3.05 ± 0.41, 3.30 ± 0.42), the good level (4.60 ± 0.28, 4.65 ± 0.49), the moderate level (5.86 ± 0.23, 6.00 ± 0.00) and the poor level (7.15 ± 0.21, 7.38 ± 1.80), males and females respectively. **Conclusion:** The LESS test scores suggest females have a greater likelihood of lower extremity injury risk compared with males.

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Keywords: Landing Error / Screening Tool / Injury Risk

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บทคัดย่อ

การบาดเจ็บบริเวณรยางค์ล่างของร่างกายเป็นบริเวณที่พบการบาดเจ็บมากที่สุดในการบาดเจ็บจากกีฬาและอาจมีการบาดเจ็บที่แตกต่างกันระหว่างเพศชายและเพศหญิง การบาดเจ็บส่งผลต่อการแข่งขันและในบางกรณีมีค่ารักษาหรือฟื้นฟูจากอาการบาดเจ็บที่สูง ดังนั้นการคัดกรองปัจจัยเสี่ยงเบื้องต้นมีความสำคัญในการป้องกันการบาดเจ็บที่อาจจะเกิดขึ้นได้ในอนาคต **วัตถุประสงค์ของการศึกษา**: เพื่อศึกษาความแตกต่างของคะแนนของเครื่องมือทดสอบการกระโดดระหว่างเพศชายและเพศหญิงในระดับมหาวิทยาลัย **วิธีการดำเนินวิจัย**: เป็นเพศชายจำนวน 13 คนและเพศหญิง 14 คน โดยเพศชายอายุ 19.5 ± 0.7 ปี น้ำหนัก 59.5 ± 2.9 กิโลกรัม และส่วนสูง 166.6 ± 2.9 เซนติเมตร และเพศหญิงอายุ 19.5 ± 0.8 ปี น้ำหนัก 58.8 ± 3.8 กิโลกรัม และส่วนสูง 166.1 ± 3.2 เซนติเมตร ทำการทดสอบการกระโดดโดยบันทึกข้อมูลด้วยกล้องวิดีโอความเร็วสูง 300 ภาพต่อวินาที จำนวน 2 กล้อง ในมุมด้านหน้าและด้านข้างของผู้ทดสอบ ผู้ทดสอบทำการซ้อมกระโดด 2 ครั้ง และทดสอบกระโดด 3 ครั้ง ทำการวิเคราะห์ข้อมูลจากวิดีโอทั้ง 2มุม โดยให้คะแนนตามใบคะแนนของ LESS และวิเคราะห์ทางสถิติโดยใช้ Independent sample t-test เพื่อศึกษาความแตกต่างของเพศชายและหญิง ที่ระดับความเชื่อมั่น $p < 0.05$ **ผลการศึกษา**: พบว่าการทดสอบการกระโดดพบว่าเพศชายมีผลคะแนนที่น้อยกว่า(ดีกว่า)เพศหญิง โดยคะแนนการกระโดดของเพศชายคือ 4.81 ± 1.52 และเพศหญิงคือ 6.11 ± 1.73 ($p = 0.050$) พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ และในระดับคะแนนของการทดสอบความผิดพลาดจากการกระโดดไม่พบความแตกต่างกันอย่างมีนัยสำคัญทางสถิติทั้ง4ระดับได้แก่ คะแนนดีเยี่ยม (3.50 ± 0.41, 3.30 ± 0.42) คะแนนดี (4.60 ± 0.28, 4.65 ± 0.49) ระดับคะแนนปานกลาง (5.86 ± 0.23, 6.00 ± 0.00) และระดับคะแนนไม่ดี (7.15 ± 0.21, 7.38 ± 1.80) ตามลำดับเพศชายและเพศหญิง **สรุปผลการศึกษา**: คะแนนของเครื่องมือคัดกรองด้วยวิธีการกระโดดสามารถประเมินความเสี่ยงของการเกิดการบาดเจ็บได้ โดยเพศชายมีคะแนนการทดสอบที่ดีกว่าเพศหญิง จึงอธิบายได้ว่าเพศหญิงมีความเสี่ยงต่อการบาดเจ็บที่รยางค์ส่วนล่างมากกว่าเพศชาย

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คำสำคัญ: เครื่องมือคัดกรอง / ความผิดพลาดขณะลงสู่พื้น / ความเสี่ยงเกิดการบาดเจ็บ

INTRODUCTION

The lower extremity is the most common body location, which has the highest injury incidence rate during sporting activity. The ankle joint is the primary site of injury, with ankle sprains accounting for 50% of all lower extremity injuries[1]. Secondly, the knee, is a prevalent site of injury, with Anterior Cruciate Ligament (ACL) injuries accounting for 50% of the total reported knee injuries[1]. Which, there may be a difference in the type of injury sustained between genders. For example, males have a greater risk of ankle injury compared to females whom have a greater risk of knee injury[2]. Injuries may be contact or non-contact related, with the level of play affecting the injury rate. For example, it has been shown that university level athletes have a higher incidence injury rate than athletes of school level age[3]. Since injuries affect loss of playing time and are in some cases expensive to treat, or rehabilitate, the prediction of future injury risk may limit incidence rates. Therefore, there is a need for pre-participation screening exams to 1) predict the risk factors related to lower extremity injury, 2) decrease injury incidence rates in both males and females, and 3) facilitate activity playing time.

General pre-participation screening exams typically use performance tests to predict injury however athletic performance *per se* may not be an optimal assessment to evaluate future injury. For example, using two hypothetical athletes who complete 30 repetitions of a sit-up exercise; one athlete may use predominantly the targeted core muscles, whilst another athlete may rely heavily on synergistic muscles to compensate completion of the test. Thus, other pre-participation screening exams, which evaluate quality movement, are easy to use, affordable, criterion clear and have good reliability, are required to predict injury.

The Landing Error Scoring System (LESS) test, developed by Padua[4], is an inexpensive clinical assessment tool to predict injury. It uses 2 standard video cameras for identifying potentially high-risk movement patterns ("errors") during a jump-landing maneuver[4]. Several previous research studies have shown the LESS test to be a reliable method to predict and screen subjects for knee (ACL) injury risk[4 5]. The risk factor, Q-angle is knee alignment measurement, valgus or knock knees, it easy to use and appear to be reliable[6]. The previous studies incidence of valgus knee in female more than in male and valgus knee increase to loading of the knee that lead to injury[7]. Therefore, the LESS test and Q-angle may potentially be used in combination to further our current understanding of lower extremity injury risk factors.

In summary, from previous studies the LESS test have been suggested to be an appropriate pre-participation screening exams to predict potential lower extremity injury but have not been applied to the university athletes and compared between genders. Therefore, this study will use the LESS test scores to screen the injury risk of male and female university students. The benefit of this study is to improve our understanding of the risk factors related to lower extremity injury, specifically in recreationally active/athletic university students.

OBJECTIVE

To study the score of screening tools in male and female in university students by The Landing Error Scoring System test (LESS) and to compare different scores level The Landing Error Scoring System test (LESS) between male and female in university students.

MATERIALS AND METHODS

Subjects

A total of 27 Mahidol University students, 14 females and 13 males, volunteered to participate in this study. All subjects were provided with a participation information sheet, which included the study objectives and procedures. The subjects provided their written informed consent and completed a questionnaire form that had been approved by the Ethics Committee of the Mahidol University Institution Review Board. Only subjects who performed sports activity at least 3 times per week, body weight between 55 to 65 kg, height between 160 to 170 cm, BMI between 19.5 to 23.5 kg/m^2 and were healthy and free of orthopaedic and musculoskeletal injury at the time of testing were included in the study. Exclusion criteria included performance of sports activity at <3 hour per week, under or over in body weight, height and BMI and current musculoskeletal injury at the time of testing or previous surgery on bone, ligament or tendon injury. Subjects were screened for injury by an Orthopaedists prior to the participation.

Data collection

General Characteristics Data

Subject general characteristics data, age, weight, height, sex, blood pressure, previous injury history, Q angle and leg length were all recorded. Prior to experimental testing, all subjects performed a 5 – 10 minute warm-up on a cycle ergometer at 0.5 kp. The subjects then asked to follow the performance test stations. All test subjects performed testing while wearing a T-shirt and shorts, and were barefoot.

MATERIALS

The Landing Error Scoring System (LESS) test uses the methods of Padua et al.[4], with two digital cameras used to video record and collect data to test intra-rater reliability. Cameras were set up at distance 346 centimeters from the landing area to the lens and at distance 80 centimeters from the lens to floor in sagittal and frontal planes to focus on the subject during the test. A box at a height of 30 centimeters was used as the start point for the jump test and a box was placed at a distance of 50% of the subject's height from the landing area.

METHODS

The Landing Error Scoring System test (LESS)

The LESS data (inexpensive field analysis using 2 standard video-cameras) is collected during a jump-landing task. The jump-landing task incorporates vertical and horizontal movements as participants jump from a 30-cm high box to a distance of 50% of their height away from the box, down to a landing area, and immediately rebound for a maximal vertical jump on landing. During task instruction, emphasis was placed on subjects jumping as high as they could once they landed from the box.

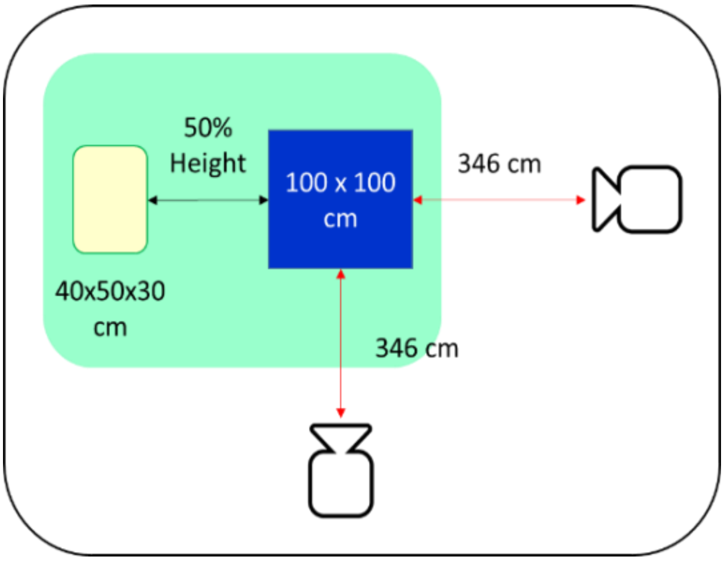

Figure 1 Cameras, box jump position and area for landing

Subjects were not provided with any feedback or coaching cues on their landing technique unless they performed the task incorrectly. After task instruction, the subject was provided as many practice trials as needed (typically 2), to perform the task successfully. A successful jump was characterized by 1) jumping off using both feet from the box, 2) jumping forward, but not vertically, to reach the landing area below, 3) landing with the entire foot of the dominant lower extremity on the landing area, 4) landing with the entire foot of the non-dominant lower extremity off the landing area and 5) completing the task in a fluid motion. The subjects were shown their performance of 3 successful trials of the jump-landing task. The total testing time, including setup, was typically 5 minutes or less per subject.

Motion Analysis: Landing Error Scoring System (LESS). Two standard video cameras capture a frontal plane and sagittal plane view of each subject as he or she performs the testing procedures. The scores analysis used criterion of LESS score sheet[8]. A higher LESS score indicates poor technique in landing from a jump, whereas a lower LESS score indicates a better jump-landing technique. There are 17 scored items in total[8].

Figure 2 The landing position on the sagittal plane and the frontal plane

Statistical analysis

The information was obtained from the collection for statistical analysis by the SPSS statistics program version 18. Independent sample t-test (two-tailed) was used to determine statistically significant compare data between female and male when quantity data is normal distribution from Kolmogorov-Smirnov Z test, but if quantity data is abnormal distribution, Mann-Whitney U test for compare data between female and male The level on significance was set at p-value less than 0.05.

RESULTS

The results of this study focus on the scoring parameters during the LESS tests in both genders. The subject characteristics, LESS scores between male and female groups and different between levels in male and female were compared in this study. The data of the LESS test scores were analyzed via video recording using the high-speed camera to record jump landing tests in the sagittal and frontal plane. All scores are presented as mean±SD.

Subject characteristics

There were fourteen females and thirteen male students from Mahidol University who volunteered to take part in this study. Only one subject's (female) data was excluded due to sustaining a knee injury during the test period. The general physical characteristics are displayed in Table 1.

Table1 General physical characteristics

The general physical characteristics and Q-angle			
	Male (n=13) (Mean±SD)	Female (n=14) (Mean±SD)	P - value
Age (years)	19.54±0.77	19.57±0.85	1.000
Weight (kg)	59.53±2.91	58.80±3.80	0.582
Height (cm)	166.61±2.90	166.14±3.20	0.692
BMI (kg/m^2)	21.44±1.01	21.30±1.34	0.761
Q-angle right side	13.23±4.65	22.29±6.87	0.001*
Q-angle left side	14.46±5.23	20.86±4.05	0.002*

Abbreviations: BMI: Body Mass Index *Difference general physical characteristics and Q-angle on left and right sides between female and male is significant at $p < 0.05$

Scores of Landing Error Scoring System and scores level of Landing Error Scoring System between female and male.

There was a difference observed in LESS scores between male and female subjects (male, 4.81± 1.52; female, 6.11 ± 1.73; p = 0.050); in Table 2.

Table2 Scores of LESS between female and male

Gender	mean	SD	T	P-value
Male	4.81	1.52	-2.064	0.050*
Female	6.11	1.73		

*Difference between female and male is significant at $p < 0.05$.

The scores level of LESS between female and male

The four level of LESS no difference, in the LESS ‘excellent’ score level (males, 3.05 ± 0.41; females, 3.30 ± 0.42; p = 0.525), the ‘good’ score level (males, 4.60 ± 0.28; females, 4.65 ± 0.49; p = 0.938), ‘moderate’ score level (males, 5.86 ± 0.23; females, 6.00 ± 0; p = 0.317) and ‘poor’ score level (male, 7.15 ± 0.21; females, 7.38 ± 1.80; p = 0.780), between genders, respectively (Table 3). The distribution of LESS score levels between males and females are presented in Figure 3.

Table3 Scores level of LESS score between female and male

Scores	Males (mean±SD)	Females (mean±SD)	P - value
Excellent (< 4)	3.05±0.41	3.30±0.42	0.525
Good (> 4 to < 5)	4.60±0.28	4.65±0.49	0.938
Moderate (>5 to < 6)	5.86±0.23	6.00±0.00	0.317
Poor (> 6)	7.15±0.21	7.38±1.08	0.780

*Difference LESS score levels between groups is significant at p >0.05

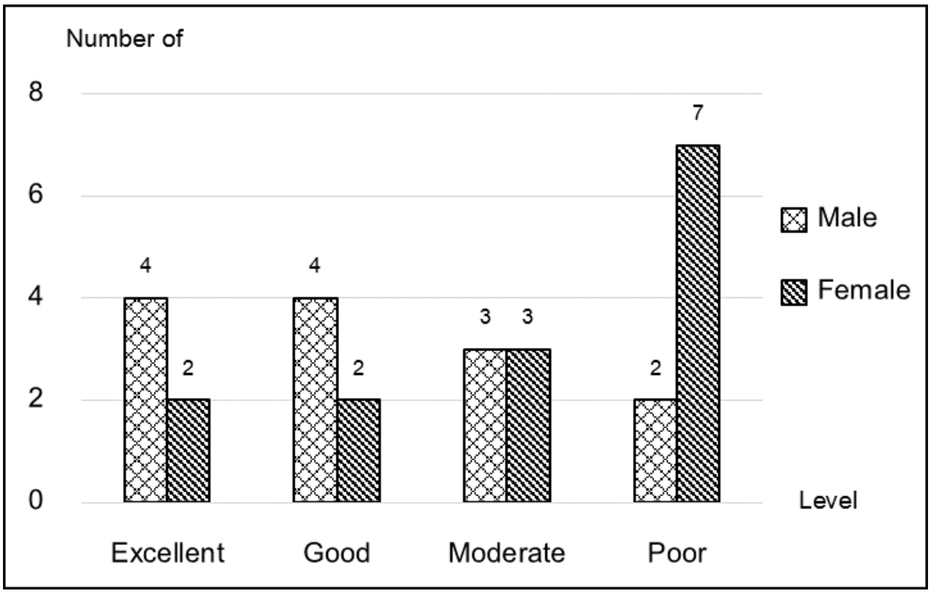

Figure 3 Distribution LESS score levels between female and male

DISCUSSION

The objective of the present study was to compare the different scores of the LESS tests between male and female university students in an attempt to predict potential lower extremity injury. The main finding was that males and females had different scores in the LESS tests. The difference in score levels classifications, e.g. 'excellent' or 'poor', were compared between males and females.

Landing Error Scoring System

There was a difference of LESS scores between genders, with males scoring lower than females. The present findings are similar to previous observations[4, 10], which reported lower LESS score in male. Similarly, in collegiate athletes, it has been reported that males have lower LESS scores compared with females both before and after exercise[11]. It has been shown that males demonstrate more at-risk landing movement patterns on the sagittal plane (limited trunk, knee and hip flexion at initial contact, and limited hip flexion throughout the landing), whereas females demonstrate more at-risk landing movement patterns on the frontal plane (knee valgus at initial ground contact and maximum knee flexion, and more frontal plane movement throughout the landing)[12]. The present findings, alongside past studies, suggest that male students have a better landing technique than females, inferring that males may have a reduced risk of lower extremity injury.

Compared scores in different scores level between female and male

The score levels e.g., 'excellent' or 'poor', between gender groups was an important analysis consideration to identify lower extremity injury risk between males and females. In the present study, there was a higher number of males in the 'excellent' level compared with females. However, there was no significant difference between the number of males or females in either the 'excellent', 'good', 'moderate' and 'poor' level classifications. The different classification levels between male and females may be a result of anatomical differences, muscle strength and/or the biomechanics of landing. Previous studies have not directly identified risk factors of non-contact ACL-injury or lower extremity injury, however in several studies [2, 10, 13], Q-angle have shown an association between these variables. In this study, Q-angle was significant difference between males and females on right and left sides, males had a lower injury risk outcome compared with females subjects may related to Q-angle. It has been shown that female basketball players, with knee injuries, have a Q-angle greater than non-injured players[6] and knee valgus in 5 degree position effect to knee aligned in the frontal plane motion, valgus motion to increase load on ACL[7], which may result in females having a higher LESS score than males, i.e. greater injury risk. Muscle strength, muscle stiffness and muscular fatigue may help to protect against injury during dynamic movement, however, muscle actions must be coordinated in sequential order. For example, there is an antagonist–agonist relationship for joint stability, and at the knee joint, co-activation of the hamstrings and quadriceps may be critical to prevent injury by providing dynamic knee stability by resisting anterior and lateral tibia translation and transverse tibia rotations[14]. In particular, women may have an imbalance between muscular strength, flexibility, and coordination within their lower extremities[15]. This may be observed when landing with an increased quadriceps activation and decreased hamstring activation; an increased ACL loading occurs during the landing of the stop-jump task and the risk for non-contact ACL injury increases. Indeed, studies on cadaveric knees suggest that hamstring activity protects the ACL from rupture, whereas the increased quadriceps force applied during landing leads to increased ACL strain[16]. The hamstring muscles are important to decrease anterior shear forces and load on ACL motion, with decreased hamstring strength possibly increasing the risk of ACL or lower extremity injury[14]. It has previously been shown that fatigue has an effect on landing performance, as demonstrated by increasing LESS scores (e.g. poor performance) in patients after ACL reconstruction and healthy controls. The ACL reconstruction group increased their pre-fatigue LESS score from 6.5 to 7.0 after fatigue and the healthy controls from in pre-fatigue from 2.5 to 6.0 after fatigue[17]. Muscular fatigue causes changes in motion, smaller knee flexion angle at initial contact, increased valgus at initial contact, more lateral trunk flexion, smaller hip flexion angle, asymmetrical foot contact and increased valgus displacement. Therefore poor biomechanics may increase risk of lower extremity injury. The study of biomechanical actions are necessary to understand the mechanism of ACL injuries and to offer effective athlete prevention programs. For example, if the hips are low and forward flexibly, hips are adducted, hips are internally rotated, knee is in a valgus position, knee in extension, and knee external rotated, the ACL is at a high risk of injury.

CONCLUSION

The main objective of this study was to compare LESS scores between male and female university students to identify potential risk of injury. The lower extremity is the most common body location where sporting injuries occur and there may be a difference in the type of injury sustained between genders. For example, males have a greater risk of ankle injury compared to females whom have a greater risk of knee injury. Since injuries affect loss of playing time and are in some cases expensive to treat, or rehabilitate, the prediction of future injury risk may limit incidence rates. Previous studies have identified the risk of lower extremity injury from scoring the quality performance of movement. The screening tools were the LESS tests; a high LESS score indicated a higher risk of lower extremity injury.

The main finding from this study was that males had a lower LESS score compared with females suggesting that males have a lower risk of lower extremity injury. A greater number of males had an 'excellent' LESS score (= 4) compared to females (= 2), with fewer males also having a lower LESS score (= 2) rated as 'poor' compared with females (= 7), therefore suggesting that males may have a reduced risk of injury.

The possible benefits related to this study include the ability to limit lower extremity injuries by using collected scores to design an exercise program to develop muscle strength outcomes and increase quality of movement in individuals/athletes. The overall benefit would be to decrease the incidence of potential lower extremity injury and prevent loss of playing time and cost of rehabilitation.

LIMITATIONS

We study had limitations, the general characteristic of males and females volunteered for included to this study had less volunteered in Mahidol university student thus, not representative of population in university student. In future of studies, next researcher may find male and female more than 100 volunteers for statistical power to detect differences scores analysis and find correlation between LESS scores and Q-angle or other factors to explain relation risk factor for analysis LESS scores.

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