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ORIGINAL ARTICLE

Recreational Female Athletes Scored Higher on the Landing Error Scoring System-Real Time

EXERCISE IS MEDICINE

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Abstract

Objective: There is no study examining the difference of LESS-RT (Landing Error Scoring System-real time) score according to gender. This study aimed to address this precise question.

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Methods: The study included recreational athletes aged 18-25 years who did not have a history of musculoskeletal injury in the last 6 months or surgery or fracture in the last 24 months, and who were classified as active according to the General Practice Physical Activity Questionnaire. Participants were evaluated using the LESS-RT. Jump-landing errors were evaluated in real-time by a sports medicine specialist.

Results: The study included 55 healthy individuals (28 females, 27 males) with an average age of 21.8 ± 1.1 years. The two sexes were not significantly different in terms of age (p=0.572). For all participants, the mean LESS-RT score was 6.93 ± 1.99. Females scored significantly higher than males (7.61 ± 1.81 vs. 6.22 ± 1.97, p=0.009). However, the LESS-RT scores were not significantly correlated with anthropometric characteristics, such as age, height, body weight, or BMI, according to sex (p>0.05). Females scored higher on LESS-RT (i.e. poorer performance), (p= 0.007).

Conclusion: Female athletes scored higher on LESS-RT. Athletes, especially females, should be assessed for biomechanical errors in jump-landing.

Résumé

Objectif: Il n’existe aucune étude examinant la différence du score LESS-RT (Landing Error Scoring System-real time) en fonction du sexe. Cette étude visait à aborder cette question précisément.

Méthodes: L’étude a porté sur des athlètes récréatifs âgés de 18 à 25 ans qui n’avaient pas d’antécédents de blessure musculo-squelettique au cours des 6 derniers mois, ni de chirurgie ou de fracture au cours des 24 derniers mois, et qui étaient classés comme actifs selon le General Practice Physical Activity Questionnaire. Les participants ont été évalués à l’aide du LESS-RT. Les erreurs d’atterrissage des sauts ont été évaluées en temps réel par un spécialiste de la médecine sportive.

Résultats: L’étude a porté sur 55 personnes en bonne santé (28 femmes, 27 hommes) dont l’âge moyen était de 21.8 ± 1.1 ans. Les deux sexes n’étaient pas significativement différents en termes d’âge (p=0.572). Pour tous les participants, le score moyen au LESS-RT était de 6.93 ± 1.99. Les femmes ont obtenu un score significativement plus élevé que les hommes (7.61 ± 1.81 contre 6.22 ± 1.97, p=0.009). Cependant, les scores du LESS-RT n’étaient pas significativement corrélés aux caractéristiques anthropométriques, telles que l’âge, la taille, le poids corporel ou l’IMC, selon le sexe (p>0.05). Les femmes ont obtenu un score plus élevé au LESS-RT (c’est-à-dire une moins bonne performance), (p= 0.007).

Conclusion: Les athlètes féminines ont obtenu des résultats plus élevés au test LESS-RT. Les athlètes, en particulier les femmes, devraient être évalués pour détecter les erreurs biomécaniques lors de la réception du saut.

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Introduction

Increased sports participation has resulted in an increased incidence of sports-related injuries. It has become increasingly clear that different sexes present with different injury profiles [1]. For instance, female athletes are more likely to sustain lower extremity injuries than males [2]. The underlying static factors include a wider pelvis, increased hip varus, femoral anteversion, as well as increased knee and external tibial torsion in the female body [2], and dynamic factors include dynamic valgus during landing [2].

On the other hand, females carry a greater risk of non-contact sports injuries, such as non-contact anterior cruciate ligament (ACL) injury [3]. Non-contact injuries account for approximately 18% of match and 37% of training injuries [4]. Due to their modifiable nature and key role in the prevention of non-contact injuries, neuromuscular and biomechanical factors are prominent in the protection of athlete health [5]. Neuromuscular and biomechanical injury risk factors are identified using laboratory-based instrumentation and testing procedures [6]. However, these methods are costly, require experienced personnel, and time-consuming, which has led researchers to seek alternative measurement methods. For this purpose, there is a need for valid and reliable measurement tools that are easy to apply in the field, require minimal time and inexpensive equipment, and that facilitate large-scale and sports-specific screening to predict injury [6]. The landing error scoring system (LESS) is a field assessment tool used to determine potentially risky movement patterns (i.e., errors) during jump-landing [6]. It has been shown by Padua et al that LESS, a system specifically used for the assessment of lower extremity biomechanics, is consistent with 3D motion analysis with good intrarater (ICC: 0.91) and interterter (ICC: 0.84) reliability. It was suggested by the authors to be a good clinical tool for assessing the risk of injury and further clinical research is needed [7]. The limitations of LESS include not being assessed in real-time and requiring video cameras [8]. To address these limitations, Padua et al. modified the system to develop a real-time jump-landing error scoring system that did not require video recording, and the system was adapted to Turkish by Ercan et al. [8,9].

A study of 27 participants found that females scored higher on LESS compared to males [10]. Again, a different study by Kuenze et al. evaluated 168 individuals with anterior cruciate ligament reconstruction using LESS and reported that females were more likely to commit landing errors [11]. However, to the best of our knowledge, there are no studies that evaluate sex differences using Landing Error Scoring System-real time (LESS-RT).

This study aimed to compare sex differences in LESS-RT scores among recreational athletes. The hypothesis of the study is that female athletes will have a higher LESS-RT score than male athletes.

Materials and methods

This study was granted ethical approval by local ethics committee (date: 05/03/2021, number: 701)

Power analysis (Gpower v3.1.9.6, Germany) revealed that a minimum of 27 subjects was needed in each group for a type I error of 0.05 and a type II error of 0.20.

The study included healthy individuals who presented to our clinic for a physical examination (athletes who applied for a pre-participation medical examination before participating in sports) who were aged 18-25 years, who did not have a history of musculoskeletal injury in the last 6 months or surgery or fracture in the last 24 months, and who were classified as active according to the General Practice Physical

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Activity Questionnaire [12,13]. Participants' anthropometric data were recorded, and the LESS-RT (9) was performed.

General Practice Physical Activity Questionnaire (GPPAQ): This questionnaire, consisting of 7 items across 3 parts, was developed in the UK to assess physical activity levels in adults in general practice, and takes between 30 to 60 seconds to complete [12]. Nogay et al. demonstrated the validity and reliability of the Turkish version [13]. The first part of the GPPAQ investigates physical activity involved in the person's work, the second part investigates physical activities performed within the previous week, and their durations, and the last part, the person's walking speed. The survey can be applied to individuals aged 16-74 and classifies physical activity into four categories, active, moderately active, moderately inactive, and inactive [13].

Landing Error Scoring System-Real Time: A 30-cm-high box with a non-slip bottom surface was placed on the floor. The procedure was explained and demonstrated to the participants before starting the test. Participants were asked to jump forward to a distance half their height, immediately followed by a second, vertical jump (Figure 1). The participants were allowed two practice rounds before the actual test. Subsequently, the test was repeated 4 times, in accordance with the test protocol. Athletes' overall LESS-RT scores were calculated by assigning each item 0, 1, or 2 points depending on errors according to the specified directions. The lowest possible score was 0, and the highest possible score was 15. A lower score indicated a better performance (i.e. fewer errors) in landing [9]. Ercan et al. demonstrated the validity and reliability of the Turkish version of LESS-RT [9]. A LESS-RT score ≤6 points indicated adequate and a LESS-RT score >6 indicated a poor landing performance [7].

Statistical analysis

Data were analyzed using SPSS version 23. Conformity to normal distribution was assessed using the Shapiro-Wilk test. Age and body weight were non-normally distributed, and height, body mass index, and LESS-RT scores were normally distributed. Sociodemographic data were analyzed using descriptive statistics (numbers, percentages, etc.). Sex differences were investigated with the independent samples t-test and chi-square test. Correlation analysis was used to investigate the relationship between independent variables and LESS-RT scores. Data were presented as mean ± standard deviation. A p value <0.05 was accepted as statistically significant.

Results

The study included 28 female (50.9%) and 27 male (49.1%) participants. The age and anthropometric data of the participants are given in Table 1, and the average LESS score was found to be 6.93 ± 1.99.
The two sexes were not significantly different in age (p=0.824). Male athletes had significantly higher height (p=0.0001), body weight (p=0.0001), and BMIs (p=0.001), and females performed significantly worse on LESS-RT (p=0.009, Table 1).

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	Female (n = 28)	Male (n = 27)	p value
Age (years)	21.7 ± 0.9	21.8 ± 1.2	0.572
Height (cm)	164.4 ± 5.5	177.3 ± 6.5	0.0001 *
Body weight (kg)	57.1 ± 5.8	73.5 ± 10.1	0.0001 *
Body mass index (kg/m^2)	21.1 ± 1.1	23.3 ± 2.6	0.001 *
Landing Error Scoring System-real time score	7.6 ± 1.8	6.2 ± 2.0	0.009 *

* p-value is less than 0.05 and significant.

Table 1: Age, anthropometric data and landing error according to sex

LESS-RT score was not correlated with anthropometric characteristics according to sex (p>0.05) *(Table 2).*

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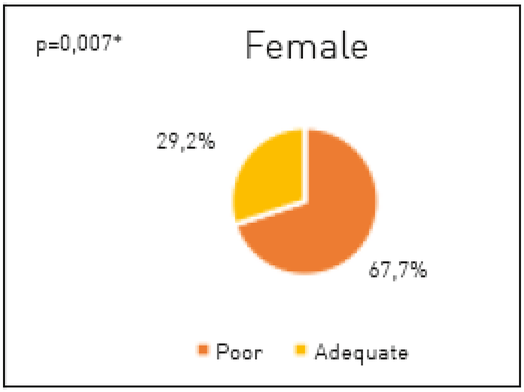
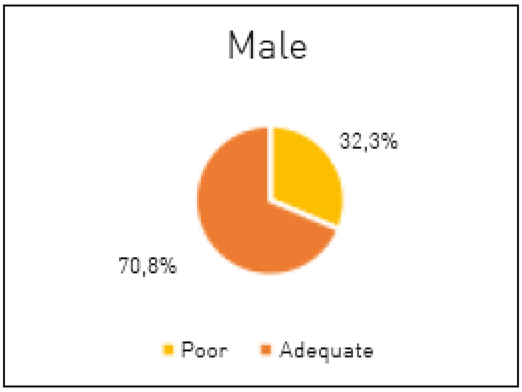
		Landing Error Scoring System-real time	
		Female (n = 28)	Male (n = 27)
Age (years)	r value	-0.234	-0.049
	p value	0.231	0.810
Height (cm)	r value	0.282	0.306
	p value	0.146	0.121
Body weight (kg)	r value	-0.147	0.249
	p value	0.457	0.210
Body mass index (kg/m^2)	r value	-0.370	-0.024
	p value	0.052	0.904

Table 2: Correlation between independent variables and LESS-RT

The sample was divided into two according to LESS-RT scores: high landing error (poor performance = LESS-RT score >6) and low landing error (adequate performance = LESS-RT score ≤6). A sex-specific analysis revealed that females were more likely to demonstrate a poor performance (p=0.007) *(Chart 1)*.





* p-value is less than 0.05

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Discussion

Different types of sports are diverse with unique injury mechanisms [14], and each athlete is at risk of musculoskeletal injury (15). A study on basketball players reported that lower extremity injuries accounted for 60.6% of practice injuries and 57.9% of game injuries [16]. Another study showed that 73.3% of time-loss lower extremity injuries were due to non-contact injuries [15]. Increased female participation to sports has resulted in an increased incidence of sports-related injuries. Lower extremity injuries are more common in female athletes than in male athletes [17].

Leppanen et al. studied 396 floorball and basketball players and found that female athletes had higher knee injury rates than male athletes (incidence ratio 3.7) [18]. Non-contact ACL injuries, in particular, are 4-6 times more common in female athletes than in male athletes [3]. As a clinical screening tool, the LESS can reliably identify athletes with potentially high-risk biomechanics [7]. In reference to the literature, we used the LESS-RT, a tool developed to predict the risk of non-contact injury, and found that females scored significantly higher ($p=0.009$) and were more likely to display poor landing performance compared to males.

A study of 23 athletes (10 females and 7 males with ACL injury and 6 healthy females) by Hewett et al. evaluated landing technique with video analysis. They found that females with ACL injury had poorer landing technique, i.e., increased lateral trunk and knee abduction angles, compared to males with ACL injury (p < or = 0.05) and healthy females (p = 0.16, 0.13, respectively) [19]. Hanzlikova et al. reviewed 52 video analysis studies using LESS as the primary outcome and concluded that females had higher LESS scores than males ($p<0.001$, mean difference = 0.6 error). The same study reported higher LESS scores in subjects with ACL injury compared to healthy controls, and that at least 6 weeks of neuromuscular and other training can significantly decrease LESS scores [20].

Smith et al. analyzed the preseason drop vertical jump test video recordings of 3876 athletes and recorded LESS scores. They analyzed the LESS scores of the 19 female and 9 male athletes that sustained ACL injury during the season and did not find a significant difference between sexes [21]. The authors argued that before adopting the LESS and other clinic-based screening tools to identify athletes at risk of injury, more studies are needed to demonstrate the predictive value of these tools across different age ranges, sexes, and levels of play and sports. However, Smith et al. included athletes of a variety of ages and sports and excluded athletes who suffered lower extremity injuries in the high-risk group (i.e., potentially higher LESS scores). Therefore, their results are controversial [6]. In our study, we used real-time assessment and found that recreational female athletes displayed poorer landing performance compared to male athletes, consistently with previous video analysis studies.Smith et al. included athletes from 8 different sports branches and in a wide age range in their study. Excluded the athletes who had a previous lower extremity injury at the beginning of the study and who could score high in the analysis. Furthermore, the researchers were not blinded to the injury situation. At the end of the study, the scores of 19 female and 9 male athletes who had injuries were compared with 64 control group athletes. Considering that biomechanical properties change according to age and sport, the evaluation of 19 athletes in different sports and ages may have caused limitations in the study. it is also debatable that researchers were not blinded to injuries. We think that less-rt can be a useful method because it is easy to apply in the field, fast results can be obtained, and more athletes can be screened at a lower cost. However, when we look at the controversial results and arguments, there is a need for studies with wide participation to be carried out on athletes with a material method that will not cause discussion, specifically sports branch and age.

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It is known that high body mass index is a risk factor for lower extremity injuries (especially anterior cruciate ligament injuries) [22,23]. In our study, as expected, there is a significant difference in age, body weight and body mass index values between the genders. No correlation was found between these variables and LESS-RT. Based on these results, we think that LESS-RT is a method that can be less affected by anthropometric features and can evaluate biomechanical features more healthily. Further studies are needed to evaluate this idea.

Padua et al. used video analysis to evaluate the jump-landing tests of 2691 participants. They found that 14 and 36% of women and 29 and 23% of men were in the excellent and poor performance groups, respectively, and concluded that women displayed poorer jump-landing biomechanics ($p<0.001$) [7]. In our study, among the subjects that displayed poor performance according to real-time assessment, 67.7% were female and 32.3% were male. While the individuals participating in the study of Padua et al. are military academy students, the individuals participating in this study are recreational athletes. It is possible to say that recreational athletes participate in less strength, balance, proprioception and biomechanical training programs compared to military academy students. The reason why female athletes are mostly in the weak group in this study may be due to the fact that they are recreational athletes. Again, there are differences in numbers between study groups. The literature indicates that females are at greater risk of injury, which should be kept in mind when preparing training programs.

The limitations of this study are including recreational athletes and not prospectively assessing the risk of injury. That said, having demonstrated sex-specific jump-landing errors using LESS-RT suggests that this test can be easily used to evaluate landing errors in clinical practice.

Conclusion

To the best of our knowledge, this is the first study to evaluate sex differences in LESS-RT scores. Our real-time assessment indicated that female athletes scored higher on LESS-RT. The higher scores of female athletes from less-rt mean that they make more biomechanical errors in landing after jumping compared to male athletes. Uncorrected biomechanical errors may increase the risk of lower extremity injury during sports. Prospective studies are needed to examine the relationship between LESS-RT scores and lower extremity injuries in female athletes.

We think that the LESS-RT scoring system can be a suitable method for the evaluation of the athlete in outpatient and field conditions, since it is low cost and allows the evaluation of the athlete in 1-2 minutes. Following the future injury status by giving appropriate exercise programs to the athletes with high scores will enable us to learn more about the advantages and disadvantages of the LESS-RT system in the future.

Practical implications

- There is no gender specific comparison with the real-time scoring system after the jump landing.
- Female athletes have worse LESS-RT scores than male athletes.
- This method appears to be advantageous for fast detection of jump error and for screening larger populations.

This study was presented as a verbal presentation at the Movement and Motor Control Congress (HAMOK

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None of financial relationship, conflict of interest and competing interest.

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BIOMECHANICS FEMALE ATHLETE LESS-RT PREVENTION