A SIMPLE JUMPING LANDING STABILITY ERRORS SYSTEM TO DIFFERENTIATE AND DIAGNOSE CHRONIC ANKLE INSTABILITY

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This study investigates whether a simplified landing stability error system can differentiate individuals with chronic ankle instability (CAI). Fifteen CAI and fifteen healthy controls performed jumping landing tasks when instructed with the landing side before (planned) or after (unplanned) take-off. Landing errors were identified as the following criteria: (1) touching the ground with the free leg, (2) standing leg leaving the force plate after landing, (3) touching the ground with the hands, and (4) lateral deviation of sternum over hips. The CAI group had a higher total error (1.70±0.65 times/trial) compared to the normal group (0.89±0.58 times/trial), with a cut-off value of 1.37 times/trial, which provides a sensitivity of 78.6% and specificity of 88.9% in differentiating CAI. The simplified landing stability error system could be a promising method for differentiation and diagnosis of CAI.

KEYWORDS: chronic ankle instability, movement analysis, jump landing, anticipation

INTRODUCTION: 40% of individuals who sustain a first-time ankle sprain develop residual symptoms, often defined as chronic ankle instability (CAI) (Doherty, 2016). Deficits during jump landing, such as decreased postural control, and altered kinematics and kinetics, are some biomechanical alterations associated with increased episodes of ankle sprains in this population (Hertel, 2019). The gold standard for detecting these biomechanical alterations remains lab-based force platforms and motion analysis systems. Still, those methods are time-consuming to scale and screen large numbers of individuals in the clinical setting (Padua, 2009). As a result, the Landing Error Scoring System-17 (LESS) (Padua, 2009) was designed to assess the injury risk during drop landing for the anterior cruciate ligament for the practitioner. However, it also needs some video cameras to record the trial before assessment and can not fully stimulate the unpredictable nature of the actual movements in the fields (Giesche F, 2021). Thus, a simple but combining unpredictable tasks simultaneously screening tool for people with chronic ankle instability needs to be developed. This study aims to determine whether landing errors in the planned condition and unplanned condition differ between people with CAI and healthy controls and whether the landing errors system can diagnose people with CAI.

METHODS: 15 participants with CAI were recruited based on the following criteria (Gribble 2014):

- (i) at least one significant lateral ankle sprain occurred more than 3 months before study participation,
- (ii) reports of “giving way” and/or recurrent sprain and/or “feelings of instability”,
- (iii) Cumberland Ankle Instability Tool (CAIT) scoring <24, FAAM-ADL score < 90%, FAAM-Sports score < 80%
- (iv) participating in >90 minutes or more of physical activity per week which involved jump landing movements.

15 healthy controls were recruited based on the previous criteria (iv). All participants provided written informed consent, as approved by the Research Ethics Committee of Loughborough University (7841) before participation.

After warm-up and familiarization procedures, the participants performed 5 times countermovement jumps from a double-leg standing position and landed with a single leg under either planned condition or unplanned conditions. The condition was controlled by the preprogrammed PowerPoint software and a foot trigger pedal. In the planned condition, the participants can read which limb (the image of the left foot or right foot) they should land on after the take-off. While in the unplanned condition, the screen was completely dark when the participant was standing on the foot trigger pedal, then, the image of the left foot or right foot was shown on the screen of the laptop after 100 milliseconds of take-off (Figure 1).

Figure 1. Demonstration of unplanned jump landing. Before the take-off, the laptop screen remained dark (A, B C). After 100 milliseconds the participant left the foot pedal, the image of the landing side was shown on the screen (D, left foot in the demonstration). Then, the participant remained in the single-leg standing position for 10 seconds(E).

The number of landing errors was spotted and counted in this process based on the following criteria:
(1) touching the ground with the free leg
(2) standing leg leaving the force plate after landing
(3) touching the ground with the hands
(4) lateral deviation of sternum over hips.
If the participants landed on a different side of the screen or landed with two legs during the unplanned condition, this trial was discarded for further analysis and repeated until the participant landed on the right leg, which was included into further analysis. The landing errors for each condition were defined as the total number of errors divided by the total number of included trials. The total errors were calculated as the sum of the landing errors for each condition.
The normality of the data was examined by the Shapiro-Wilk test. The group comparison was analysed with an independent t-test and receiver operator characteristic curve analyses were included to select a test cut point, followed by computation of sensitivity and specificity. The α level was set at 0.05. The effect size of group comparison was analysed with Cohen's d.

RESULTS: The landing errors in both groups are displayed in Figure 2. The CAI group exhibited higher planned landing errors (P=0.028), unplanned landing errors (P=0.017) and total errors (P=0.003) compared to the normal group.

Table 1: landing errors comparison.

	CAI group	Control group	P	Effect size
Landing errors (times/trial)				
Planned condition	0.61± 0.60	0.22± 0.20	0.028	0.86 (0.09-1.63)
Unplanned condition	1.15± 0.49	0.69± 0.43	0.017	0.96 (0.17-1.74)
Total errors	1.70 ± 0.69	0.89 ± 0.58	0.003	1.22 (0.40-2.01)

The ROC curve analysis revealed that the total errors model showed the largest area under the curve (AUC) with a value of 0.819 compared to the planned landing errors model (0.796) and the unplanned landing errors model (0.783) (**Figure 2**.). AUC analysis suggested a cut-off value of 1.37 times/trial in the total errors model achieving an optimal screening property: 78.6% sensitivity and 88.9% specificity.

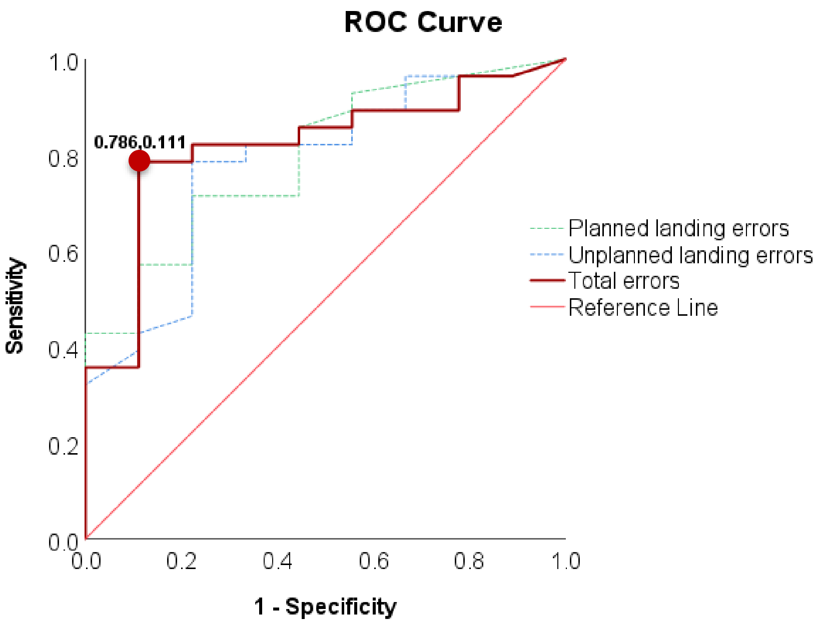

Figure 2. ROC curve for total errors, planned landing errors and unplanned landing errors. Among them, the total errors model revealed the largest area under the curve 0.819, with a cut-off value of 1.37 times/ trial (sensitivity 0.786 and specificity 0.889).

DISCUSSION: This study tested a laptop-based screening method evaluating the errors in 10 jump landing trials including planned and unplanned conditions among people with CAI. The result indicated that people with CAI had more landing errors either in the planned condition or the unplanned condition. The errors system is the first to combine the unplanned jumping landing tasks into the testing tasks and revealed a good sensitivity (0.786) and excellent specificity (0.889), which emerges as a simple and promising method to differentiate people with CAI. The innovative approach of incorporating both planned and unplanned jump landings in the assessment not only highlights the postural stability challenges faced by individuals with CAI but also reveals the importance of real-world simulation in screening methodologies.
The traditional Landing Error Scoring System-17 (LESS-17) was proposed by Padua in 2009 to evaluate risks related to anterior cruciate ligament injuries and tested its function in the CAI population by Harriss J in 2019, they utilised the camera to capture the trial process and spotted how many times occurred on 17 types of errors manually. Although it is less time-consuming compared to the gold standard method, 3-dimensional motion analysis, the 17-item approach restricts its application for large-scale screening. This study utilized only 4 items to detect the group differences successfully among people with chronic ankle instability and controls. Apart from that, the LESS-17 implemented the 30 cm drop jump task in their assessment, which is too simple to stimulate some real-world unpredictable circumstances: on the pitch, the football player needs to tackle the ball when dealing with the position of the teammates or opponents, which needs them to adjust their body movements as react to external stimuli. The method proposed in this study provides a simple but promising tool to screen people with chronic ankle instability.
Despite these advancements, the method has some limitations. Firstly, the inevitable subjective bias during error evaluation. Future research should focus on minimizing subjective bias promptly. Secondly, the repeatability and validity of the error system are still unknown. More studies are needed to explore whether it has a comparable diagnosis function to the gold standard (e.g. center of pressure measurements via force plate (Linens SW, 2014)) or the LESS-17. Lastly, the current errors system does not fully consider the interpretation of the unsuccessful trials, such as landing on both legs and wrong legs, the specific mechanisms for the inadequate ability of transforming to the requested leg during landing needs further exploration.

CONCLUSION:

Individuals with CAI exhibited compromised stability during jump landing tasks compared to healthy controls. The jump landing stability errors system emerges as a promising and cost-efficient method for differentiation and diagnosis of CAI.

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