



Unmasking Functional Deficits after Ankle Sprain: A Comparative Analysis of Dynamic Hop Tests

Ahmed Almansour¹, Abdullah Almutairi², Naif Alrashdi³, Sultan Alanazi⁴, Ahmed Almutairi⁵ and Mohamed K. Seyam⁶

^{1,3,4,6}Department of Physical Therapy and Health Rehabilitation, College of Applied Medical Sciences, Majmaah University, Al-Majmaah 11952, Saudi Arabia

²Department of Physical Therapy and Health Rehabilitation, King Khalid Hospital, Al-Majmaah, Saudi Arabia

³Health and Scientific Colleges Research Center, Majmaah University, Majmaah, Saudi Arabia

⁵Medical Rehabilitation and Long Term Care Department, Riyadh, Saudi Arabia

Author Designation: ¹Associate Professor, ²Specialist, ³Assistant Professor, ⁴Assistant Professor, ⁵Specialist, ⁶Associate professor

*Corresponding author: Dr. Ahmed M. Almansour (e-mail: ah.almansour@mu.edu.sa).

©2026 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>)

Abstract Background: Ankle sprains commonly result in persistent functional deficits and delayed return to sports activities. While Functional Performance Tests (FPTs) guide return-to-sport decisions, their sensitivity varies. Side Hop Test (SHT) requires dynamic stability and rapid lateral control and therefore can detect subtle deficits better than the Single-Leg Hop (SLHT). Henceforth the present study was aimed to compare both tests and examine their relationship with self-reported ankle instability using the Cumberland Ankle Instability Tool (CAIT). **Methods:** Twenty-eight male participants with a history of ankle sprain within the previous 1-12 months completed the CAIT. Each participant performed the Single-Leg Hop Test (SLHT) and Side Hop Test (SHT) on both injured and uninjured ankles. **Results:** Side-HT completion time was significantly longer for the injured ankle (8.56 ± 4.18 s) compared with the uninjured ankle (7.82 ± 3.38 s; $t = 2.27$, $p = 0.03$). Although SLHT distance was lower for the injured ankle (128.4 ± 33 cm) than the uninjured ankle (132 ± 35 cm), this difference was not statistically significant ($t = -1.45$, $p = 0.15$). Pearson correlation analysis showed a significant negative association between CAIT scores and Side-HT performance for both injured ($r = -0.39$, $p = 0.041$) and uninjured ankles ($r = -0.43$, $p = 0.023$), whereas no significant relationship was observed with SLHT. **Conclusion:** The Side Hop Test appears to be a more sensitive measure for identifying functional deficits following ankle sprain. Future research should establish clinically meaningful cut-off values at specific post-injury time points to support safe return-to-sport decision-making.

Key Words Chronic Ankle Instability, Functional Performance Tests, Side Hop Test, Single-Leg Hop Test, Return-To-Sport Assessment

INTRODUCTION

One of the most significant problems in sports and rehabilitation medicine is ankle sprain as it is one of the most widespread musculoskeletal injuries in the world. Evidence today indicates that Lateral Ankle Sprain (LAS) frequently leaves permanent functional impairments, delayed recovery and disability despite seemingly improving following clinical recovery [1,2,3]. According to the recent professional opinion, ankle sprains cannot be regarded as non-traumatic injuries anymore as they have a close correlation with repeated injuries, neuromuscular dysfunction and persistent symptoms [4].

Ankle sprains are a significant burden in terms of health and economy to the population. The data of the surveillance shows that ankle sprains are among the most frequent injuries caused by sport all over the world [4,5,6]. Worryingly, almost 4050 percent of patients do not consult a medical professional

after ankle sprain resulting in higher chances of failure to rehabilitate the injury and reinjury [7,8]. Longitudinal studies continuously reveal that up to 6070 percent of persons have recurrent sprains that may culminate into Chronic Ankle Instability (CAI), which is recurrent giving way, pain, weakness and impaired functional ability [9,10].

Accurate detection of residual functional deficits after ankle sprain is mandatory for guiding rehabilitation and safe return to sports activity. Literature review suggests that Functional Performance Tests (FPTs) are widely used because they not only assess strength and neuromuscular control but also balance, as well as dynamic stability, which are the key domains affected in Chronic Ankle Instability (CAI) [10,11]. Hop-based tests including the Single-Leg Hop Test (SLHT) and Side Hop Test (SHT) are particularly valuable as they replicate sport-specific dynamic loading and challenge real-time neuromuscular control more effectively

than static or isolated clinical tests [3,4]. However, emerging evidence suggests that different FPTs vary in sensitivity and may show inconsistent relationships with patient-reported instability, highlighting a clear need to identify the most responsive test for detecting residual impairments [10,12].

Recent evidence suggests that lateral, time-based hop tasks better expose sensorimotor deficits in chronic ankle instability. Side-hop movements impose rapid mediolateral loading, challenging proprioception, dynamic balance and neuromuscular control-key domains impaired in CAI [2,13]. In contrast, forward hop tests primarily assess linear power and may miss subtle deficits, showing lower sensitivity in detecting instability [14]. Moreover, side-hop performance has demonstrated stronger associations with perceived instability and better discrimination of functional deficits [11], supporting its role as a more responsive clinical measure.

Therefore the present study aimed to compare the effectiveness of the Single-Leg Hop Test (SLHT) and the Side Hop Test (SHT) between injured and uninjured ankles, as well as examine their relationship with self-reported ankle instability using the Cumberland Ankle Instability Tool (CAIT). It is thus hypothesized that the Side Hop Test is more sensitive than the Single-Leg Hop Test in detecting residual impairments and shows a stronger association with CAIT scores.

METHODS

The study design was Cross-sectional in nature. The study was performed at Rehabilitation Clinic in Majmaah University, Saudi Arabia. Ethical approval from the Institutional Review Board (IRB) of Majmaah University was taken prior to the commencement of the study (IRB No.: MUREC; HA-01-R-088; MUREC-Jan25/COM-2021/20-3).

Participants aged 18–30 years with a history of unilateral ankle sprain within the past 12 months were included. All participants had a pre-injury physical activity level of 1 or 2 according to the Noyes et al. classification. Individuals with any other recent lower-extremity injury, or with neurological or vestibular disorders affecting balance or hopping performance, were excluded. A total of 28 participants were included in the study and informed consent was obtained from all participants prior to data collection.

Determination of sample size was done using Cohen power analysis for detecting mean differences, likely based on a t-test model. The calculation incorporates the significance level ($\alpha = 0.05$), statistical power (80%) and an assumed effect size (Cohen's d), using the formula $n = (Z_{\alpha} + Z_{\beta})^2 / d^2$. Although the method was appropriate, the specific effect size used was not reported.

Two validated Functional Performance Tests (FPTs), namely Single-Leg Hop Test (SLHT) and Side Hop Test (SHT) were used to assess functional performance [14,15]. Before the commencement of actual test, the participants were made to perform 5 minutes of warm-up

on a stationary bicycle. To mitigate the learning effects and intra-individual variation, participants were allowed to perform two practice trials followed by three test trials on both injured and uninjured ankles for each test. The cases which were not done as per the standard guidelines were retried. The participants were given a 30-second rest between the successive trials and a 1-minute rest between the tests to ensure that fatigue was reduced [16].

Single-Leg Hop Test (SLHT)

In this test, the participants were instructed to stand on single leg behind the starting line with hands behind the back as shown in Figure 1. The participants were then instructed to jump forward as far as possible landing on the similar limb while maintaining the balance. The distance between the 2 spots was recorded using a measuring tape, named as Hop Distance, measured in centimetres. Three successful trials per limb were averaged and were taken as the SLHT score of that limb.

Side Hop Test (Side-HT)

For the Side-HT, participants stood on the tested limb with hands positioned behind the back and were instructed to perform repeated lateral hops of 30 cm, returning to the starting position for a total of 10 repetitions. The time required to complete each trial was recorded to the nearest 0.01 second. The mean completion time of three successful trials was calculated and used as the Side-HT score (seconds) for each limb (Figure 2).

Cumberland Ankle Instability Tool (CAIT)

The Arabic version of the Cumberland Ankle Instability Tool (CAIT) was used for the measurement of self-reported ankle instability [17,18]. This self-administered questionnaire was used to classify participants based on the presence and severity of functional ankle instability prior to performance testing. The total scores was between 0 and 30 with higher scores depicting more ankle stability. The cut-off point against ankle instability has been set to a score of 27 and less [17]. While the CAIT scores enabled subgroup comparison between stable and unstable ankles, the SLHT and SHT provided objective measures of functional deficits.

Statistical Analysis

Statistical packages were done on the Statistical Package of the Social Sciences (SPSS) 25 version (IBM Corp., Chicago, IL, USA). All outcome measures were reported using both descriptive and inferential statistics, with statistical significance level set as $p < 0.05$. Paired-samples t-tests were applied to compare between Single-Leg Hop Test (SLHT) and Side Hop Test (SHT), whereas correlation between functional performance and CAIT scores was estimated using Pearson correlation coefficients (r) for both injured and uninjured ankles.

RESULTS

Participant Characteristics

Twenty-eight participants with a history of unilateral ankle sprain within the previous 12 months were included in the analysis. All participants were aged between 18 and 30 years and had a pre-injury physical activity level of 1 or 2 based on the Noyes classification. Demographic characteristics of the participants are presented in Table 1.

Comparison of Functional Performance between Injured and Uninjured Ankles

Descriptive statistics and paired comparisons of functional performance outcomes are presented in Table 2. The paired-

samples t-test revealed a significant difference in Side-Hop Test performance between injured and uninjured ankles. Specifically, completion time was significantly longer for the injured ankle (8.56 ± 4.18 s) compared with the uninjured ankle (7.82 ± 3.38 s; $t = 2.27$, $p = 0.03$). On the other hand, the hop test for SLHT was lower for the injured ankle (128.4 ± 33.0 cm) in comparison to the uninjured ankle (132.0 ± 35.0 cm), with difference between the two not statistically significant ($t = -1.45$, $p = 0.15$).

Relationship between Functional Performance and Self-Reported Ankle Instability

With reference to analysing the correlation between Functional Performance and self-reported ankle instability

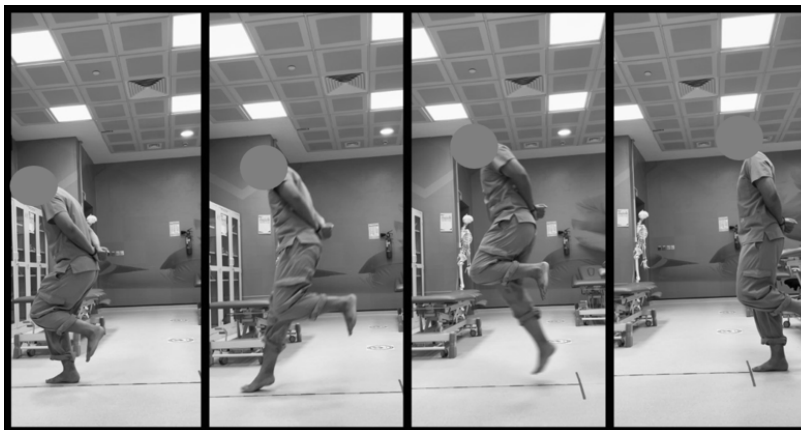


Figure 1: Showing Single-Leg Hop Test for Distance (SLHT)

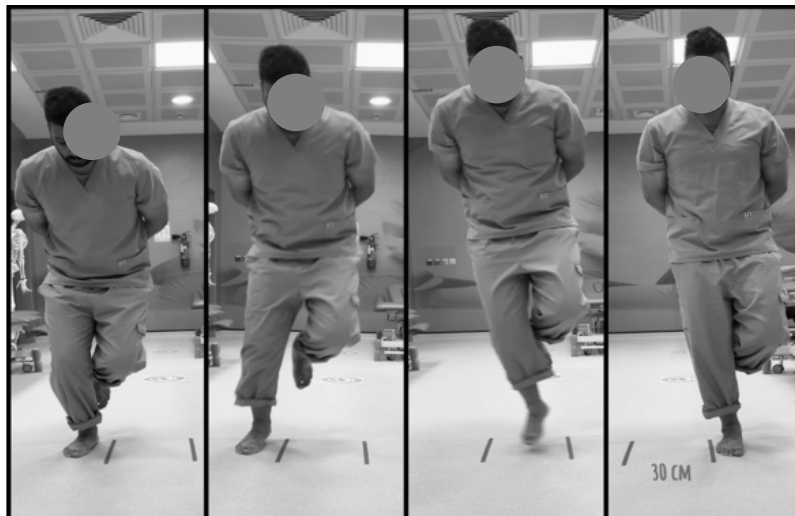


Figure 2: Side Hop Test (Side-HT)

using CAIT score, it was observed that the CAIT score for the cohort was 17.68 ± 7.37 , indicating the presence of ankle instability. Pearson correlation analysis revealed a significant negative relationship between CAIT scores and Side-Hop Test (SHT) performance for both the injured ankle ($r = -0.39$, $p = 0.041$) and the uninjured ankle ($r =$

-0.43 , $p = 0.023$). Lower CAIT scores (greater perceived instability) were associated with longer Side-HT completion times. No significant correlations were observed between CAIT scores and SLHT performance for either the injured or uninjured ankle ($p > 0.05$). Correlation results are summarized in Table 3.

Table 1: Demographic Characteristics of Participants

Variable	Mean±SD
Age (years)	24.57±3.8
Weight (kg)	68.21±9.5
Height (cm)	172.4±7.1
Body Mass Index (kg/m ²)	22.8±2.0

Table 2: Comparison between Injured and Uninjured Ankles

Outcome	Injured ankle (Mean±SD)	Uninjured ankle (Mean±SD)	Statistics
SHT (s)	8.56±4.18	7.82±3.38	t = 2.27; p = 0.03*
SLHT (cm)	128.4±33.0	132.0±35.0	t = -1.45; p = 0.15

SHT: Side Hop Test, SLHT: Single-Leg Hop Test, s: Seconds, cm: centimetres, Significant at p<0.05

Table 3: Correlations between CAIT and Functional Performance Tests

Outcome	r (p-value)
Side-HT (injured ankle)	-0.39 (0.041)*
Side-HT (uninjured ankle)	-0.43 (0.023)*
SLHT (injured ankle)	0.25 (0.19)
SLHT (uninjured ankle)	0.27 (0.17)

CAIT: Cumberland Ankle Instability Tool, Side-HT: Side Hop Test, SLHT: Single-Leg Hop Test, Significant at p<0.05

DISCUSSION

The current research was meant to compare the functional performance of the injured and the healthy ankles and also to investigate the association between hop performance and self-reported ankle instability. The findings of our study showed that the Side Hop Test reported an important decrease in functional performance of the injured ankle, but the Single-Leg Hop Test did not report any statistically significant between-limb difference. Likewise, performance in Side-Hop Test was strongly linked with perceived ankle instability as a measure with CAIT, but not with Single Leg Hop Test.

Injured ankles took a much longer period of time in the Side-HT than the uninjured ankles. This is probably a manifestation of chronic shortage of frontal-plane stability, proprioception and neuromuscular control, herself being well-reported effects of lateral ankle sprain and chronic ankle instability [1,4,10]. Lateral hopping exercises put significant load on peroneal muscle activity and sensorimotor integration, which are often weakened following ankle sprain [12,15].

The fact that there are no meaningful differences in SLHT distance is consistent with the results of the previous studies where it was observed that hop test relying on distance might not be sensitive to ankle-specific deficits [11]. Alternatively, Straight-line hopping mainly represents the power of lower limbs and not necessarily active stability of the ankle [3,10].

The clinical relevance of the Side-HT is also supported by the correlation analysis. Patients who reported higher perceived instability showed worse lateral hopping, as was expected by other studies that ascribed patient-reported instability to multi-directional functional activities [3,12,16]. Conversely, the correlation between SLHT and CAIT scores was not significant, which supports the fact that hop distance in the sagittal plane alone might be not a good indicator of perceived instability.

These results of our findings are also of decent value in terms of return-to-sport decision-making. The most recent consensus statement suggests that should not rely on an individual metric of performance [4]. The inclusion of lateral

and time-based tests as well as patient-reported outcome scales could offer a more detailed approach to residual deficits [10,12]. So, to infer lateral, multi-directional movements better reflect patient-reported instability better as compared to sagittal plane performance alone. While the data support the superior clinical utility of SHT, interpretations regarding the underlying mechanisms-such as neuromuscular control or proprioceptive deficits-should be presented cautiously as explanatory hypotheses rather than definitive conclusions. Thus, Clinically, these results reinforce the importance of incorporating multi-directional, time-based functional tests alongside patient-reported outcome measures in return-to-sport decision-making, rather than relying on a single performance metric, thereby enabling a more comprehensive assessment of residual functional limitations.

The study had some few limitations too. The study sample size was small and moreover emphasis on younger adults, suggests that the results cannot be generalized. In addition, the severity of injury and number of previous sprains were not stratified in the present even after it was shown that these variables do play a role in outcomes [10,12]. Moreover, the present study did not consider any specific biomechanical and electromyographic measurements using sophisticated equipment's to substantiate the claims.

CONCLUSION

This study demonstrated that the Side Hop Test is more sensitive than the Single-Leg Hop Test in identifying residual functional deficits following ankle sprain injuries. The Injured ankles showed significantly poorer lateral hopping performance, which was also strongly associated with self-reported ankle instability. In contrast, hop distance alone failed to detect meaningful between-limb differences or reflect perceived instability. These findings highlight the importance of incorporating lateral, time-based functional tests alongside patient-reported measures when assessing recovery and readiness to return to activity after ankle sprain.

Therefore, future studies should include a larger and more diverse sample across different age groups to improve the generalizability of findings and allow subgroup analyses. Incorporating objective biomechanical and electromyographic assessments would further strengthen the evidence by providing deeper insights into underlying neuromuscular deficits associated with ankle instability.

REFERENCES

- [1] Hertel, J. and R.O. Corbett. "An updated model of chronic ankle instability." *Journal of Athletic Training*, vol. 54, no. 6, 2019, pp. 572–588.
- [2] Gribble, P.A. *et al. British Journal of Sports Medicine*, vol. 55, no. 6, 2021, pp. 309–319.
- [3] Picot, B. *et al. Sports Medicine*, vol. 54, no. 2, 2024, pp. 245–260.
- [4] Doherty, C. *et al. Sports Medicine*, vol. 54, no. 1, 2024, pp. 85–102.
- [5] Al Adal, S. *et al. Journal of Foot and Ankle Research*, vol. 12, 2019, p. 12.

- [6] Waterman, B.R. *et al.* *Journal of Bone and Joint Surgery American Volume*, vol. 93, no. 24, 2021, pp. 2279–2284.
- [7] Vuurberg, G. *et al.* *British Journal of Sports Medicine*, vol. 52, no. 15, 2018, pp. 956–968.
- [8] Picot, B. *et al.* *Sports Medicine*, vol. 54, no. 2, 2024, pp. 245–260.
- [9] McKay, G.D. *et al.* *British Journal of Sports Medicine*, vol. 35, no. 2, 2001, pp. 103–108.
- [10] Delahunt, E. *et al.* *British Journal of Sports Medicine*, vol. 59, no. 1, 2025, pp. 12–20.
- [11] Docherty, C.L. *et al.* *Journal of Athletic Training*, vol. 40, no. 1, 2005, pp. 30–34.
- [12] Doherty, C. *et al.* *American Journal of Sports Medicine*, vol. 47, no. 4, 2019, pp. 995–1003.
- [13] Itoh, H. *et al.* *Knee Surgery, Sports Traumatology, Arthroscopy*, vol. 6, no. 4, 1998, pp. 241–245.
- [14] White, K. *et al.* *Journal of Orthopaedic and Sports Physical Therapy*, vol. 48, no. 7, 2018, pp. 567–575.
- [15] Hubbard-Turner, T. and M.J. Turner. *Journal of Athletic Training*, vol. 50, no. 7, 2015, pp. 742–747.
- [16] Houston, M.N. *et al.* *Journal of Athletic Training*, vol. 55, no. 4, 2020, pp. 371–377.
- [17] Hiller, C.E. *et al.* “The Cumberland Ankle Instability Tool: A Report of Validity and Reliability Testing.” *Archives of Physical Medicine and Rehabilitation*, vol. 87, no. 9, 2006, pp. 1235–1241.
- [18] Korakakis, V. *et al.* “Cross-Cultural Adaptation and Validation of the Arabic Version of the Cumberland Ankle Instability Tool.” *Disability and Rehabilitation*, vol. 41, no. 8, 2019, pp. 948–953.