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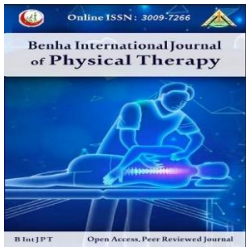

Original research

Assessment of Static and Dynamic Balance among College Students with Functional Ankle Instability:Cross-Sectional Study

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Abstract

Background: Chronic Functional Ankle Instability (FAI) is a common musculoskeletal disorder that is characterized by recurring giving away of the foot among physically active individuals, especially college students. Functional instability is related to postural control deficits, compromised neuromuscular control, and proprioceptive deficits. This study fills the assessment gap using valid tests to help reach accurate assessment. Although previous research has indicated balance abnormalities in individuals with FAI, the extent to which static and dynamic balance are affected remains unclear, especially among college students. **Purpose:** This study aims to assess static and dynamic balance, and functional performance changes among students' colleagues with functional ankle instability (FAI). **Methods:** Thirty-eight unilateral ankle instability patients (mean age 20.4 ± 1.29 years) with seventy-six legs were divided into two groups: an experimental group (N = 38, unstable ankles) and a control group (N = 38, unaffected ankles). Static and dynamic balance and functional performance were assessed by single-leg stance (SLS) with eyes open and closed, the y-balance test and the side hop test, respectively**. Results:** The values of effect size (Cohen's d) were 0.49 for side hop (seconds), 0.36 for SLS eye open (seconds), 0.73 for SLS, eye closed (seconds), and 0.96 for Y-Balance. Significant differences in balance and functional performance were found between affected and non-affected limbs. The affected limb showed poorer performance in the side hop test (P = 0.007), SLS test with eyes closed (P = 0.004), SLS test with eyes open (P = 0.044), and the Y-Balance test ($p < 0.001$). **Conclusion:** College students with FAI might have significant deficiencies in both static, dynamic balance as well as functional performance. These deficits increase the risk of recurrence. **Keywords**: Ankle Sprain, Single leg stance, Y-balance, side hop test, Instability.

Introduction

Lateral ankle instability is characterized by recurring giving way to the outer (lateral) side of the ankle during standing or even when walking. It frequently develops after repeated ankle sprains[1]. An acute ankle sprain that fails to be treated by physical therapy leads to ankle instability[2]. Between six weeks and eighteen months after suffering a lateral ankle sprain, 55% to 72% of people continue to have ankle sprain symptoms and

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instability symptoms[3]. The incidence of Chronic ankle instability is 25% after an ankle sprain and 20% among physically active adolescents in otherwise healthy health. Although over 15% of instances progress to ankle instability, the public still considers ankle sprains as not dangerous injuries[4]. Ankle sprains occur most frequently between the ages of 15 and 19; however, there is no appreciable difference in the frequency of lateral ankle sprain between males and girls [5].

Both mechanical instability and functional instability were explored in the original CAI hypothesis[6].Deficits in proprioception, strength, neuromuscular control, and postural control are all considered forms of functional instability[7]. Anatomical changes that occur after an initial ankle sprain, such as pathologic laxity, impaired arthrokinematics, and the start of degenerative joint disease, are evidence of mechanical instability[8].

Usually, functional performance tests are used to evaluate the ankle's condition in situations of chronic ankle instability (CAI). Functional instability brought on by several factors, including diminished neuromuscular firing patterns, proprioception and sensation, strength deficiencies, and foot control, results in affection for balance[9]. Specific functional tests can detect limits in functional performance and muscle strength inadequacies; consequently, these tests can be used as a guide for rehabilitation's success[10]. The frequency of functional ankle instability is particularly high in young, physically active people[11]. Therefore, this study aims to assess the impacts of functional ankle instability (FAI) on static and dynamic balance, and functional performance among college students. By addressing specific balance impairments, this study seeks to contribute to the development of evidence-based interventions that improve functional outcomes and lower the risk of re-injury.

Methods

Study Design

This was a cross-sectional study design that included 38 participants aged between 18 and 22 years who were diagnosed with functional ankle instability and equally divided into two groups. Group A (experimental group) consisted of 38 participants with functional ankle instability, and Group B included the unaffected limb of the 38 participants**.**

Setting

The study was conducted at the biomechanics lab at Al-Hayah University between May and October 2024. All data collection and procedures were conducted in a controlled laboratory environment.

Ethics Approval and Trial Registration

The study received ethical approval from the Faculty of Physical Therapy, Cairo University research ethical committee (P.T.REC/012/005361). The study followed the principles and standards of Helsinki. All patients signed an informed consent after explaining the full details of this study.

Participants

The recruited patients were included based on the following inclusion criteria: thirty-eight students aged 18-22 years, complained of FAI with the most recent sprain about three months old and had at least one unilateral lateral ankle sprain requiring at least three days of immobilization. Patients were excluded if they had any of the following: history of previous ankle surgery, bilateral ankle instability, ankle arthritis, or fractures. A priori power analysis using G*Power 3.1.9.7. The calculation was based on the single leg stance test with an effect size of 0. 0.698164 obtained from a pilot study on 8 participants who were continued in the study, with α set at 0.05 and power (1 – β err prob) at 80%. A total of 38 participants were required for the study.

Standardization Procedures

To reduce measurement variability, the principal investigator performed all experimental preparation, instructions, and data collection. Participants were given standardized instructions for positioning. Trials were discarded and repeated if any error was observed.

Assessment procedures

Static Balance (Single Leg Stance)

The single-leg Stance test (SLS) is a balance assessment tool used in clinical settings to monitor musculoskeletal conditions, with an interrater reliability of the test is 0.898[12]. Students performed the SLS test by standing on one foot

without shoes, with hips level, and knee bent of the contralateral limb. First, the test was done with eyes open, their eyes fixed on a wall spot and then repeated with closed eyes. The researcher observed if the patient's legs contacted one another, their arms moved from their initial posture, or their feet touched the ground. The researcher documented the results of the three trials that were carried out and measured the ability to maintain balance in seconds. The normal value of the SLS test with the eye open is 43.5 ± 3.8 and with the closed eye is 8.5 ± 9.1 seconds[13].

Dynamic balance (Y balance Test)

The Y balance test assesses balance control and dynamic stability. This tool assesses an individual's possibility of injury. It is reliable and accurate. There is a good interrater test-retest reliability with an acceptable degree of measurement error in the lower quarter (LQYBT) across numerous raters screening active-duty service members; with excellent reliability (ICC = 0.88-0.99)[14]. The anterior, posterolateral, and posteromedial components of YBT were the only ones assessed. The dynamic neuromuscular function of the lower limbs and unilateral balance were assessed. In this test, the student stood on one leg and attempted to use the non-fixed toe to reach the furthest points along the lines in the anterior, posterolateral, and posteromedial directions while maintaining a fixed foot planted in the center of the axis of a marked Y-shaped figure on the floor. Test-takers were given both visual and verbal cues. After striking the line at its furthest range, the subject was to return to the starting point. Six administrations of the learning test were conducted, with the individual switching between the three directions and support feet[15]. The maximum range achieved could also be calculated along with the composite score, which is a normalized sum of the range of the limbs. By dividing the sum of the three distances by three times the limb length (in centimeters) and then multiplying the result by 100, the composite score was determined. A composite score of 94% of limb length on the YBT or a difference in the anterior range of 4 cm from the contralateral limb were indicators of the risk of injury, which was also evaluated using the normalized score[16].

Functional performance (Side hop test)

The side hop test is a valuable tool for evaluating lower limb function in clinical and research settings, measuring performance changes during rehabilitation, and validating training direction. Its strong inter-rater reliability ranges from 0.83 to 0.91[17]. It would have been brought about by improvements in muscle strength, joint stability, and neuromuscular control. In the side hop test, students stood on one leg, 30 cm from two parallel lines. They were told to hop laterally over the lines and then, as fast as they could, return to the starting place ten times with the same leg. They were allowed to move their arms freely during the test. It was noted how long it took each leg to perform 10 repetitions; a shorter time meant a better result. The side hop test ≥ 13 seconds for 10 repetitions is positive and patients cannot produce normal functional performance[18].

Statistical Analysis

All statistical analyses were conducted using Python, with pandas for data handling. Descriptive statistics include means, standard deviations, ranges, and percentages. The Shapiro-Wilk test was employed to assess the normality of distribution. Based on the results of normality testing, paired t-tests were used to compare static and dynamic balance and the functional performance parameters between affected and non-affected limbs. The level of significance was set at $p < 0.05$.

Results

A total of 38 college students (28 males, 10 females) with FAI participated in this study. Detailed demographic and clinical characteristics are presented in Table 1. Compare functional performance parameters between the affected and non-affected limbs. The results in Table 2 were related to significant differences in static and dynamic balance, and functional performance between affected and non-affected limbs. The values of effect size (Cohen's d) were 0.49 for side hop (Seconds), 0.36 for SLS eye open (seconds), 0.73 for SLS, eye closed (seconds), and 0.96 for Y-balance (%). Significant differences in balance and functional performance were found between affected and non-affected limbs. The affected limb

showed poorer performance in the side hop test (P = 0.007), SLS test with eyes closed (P = 0.004), SLS test with eyes open (P = 0.044), and the Y-balance test (p < 0.001). The affected limb showed poorer performance in the side hop test (P = 0.007), the SLS test with eyes closed (P = 0.004), SLS test with eyes open (P = 0.044), and Y-balance test (P < 0.001)

Table (1): Demographic data of the study (Mean ± SD (Range) / Count (%))

***Demographics* Variable**	**N**	**Mean ± SD**
Age (years)	38	20.4 ± 1.29 (18.0–22.0)
Weight (Kg)	38	70.9 ± 9.9 (50.0–87.0)
Height (Cm)	38	173.1 ± 8.7 (155.0–190.0)

SD: Standard deviation , *: significance, N = sample size

Table (2): Comparison between affected and non-affected Limb

Variable (Strength Test) (N=38)	**Mean ± SD (Affected)**	**Mean ± SD (Non-Affected)**	**t-Value**	**p-Value**	**Effect Size (Cohen's d)**
Side Hop (Seconds)	18.08 ± 4.14	16.28 ± 3.14	-2.88	**0.007**	0.49
SLS (Seconds, Eye Open)	56.40 ± 20.56	64.55 ± 24.11	2.08	**0.044**	0.36
SLS (Seconds, Eye Closed)	7.63 ± 1.99	9.21 ± 2.33	3.11	**0.004**	0.73
Y-Balance (%)	63.32 ± 9.10	71.39 ± 7.68	6.48	**< 0.001***	0.96

SD: Standard deviation *: significance SLS= Single-Leg Stance; N = sample size for paired comparisons between affected and non-affected limbs; Mean ± SD = mean value ± standard deviation; t-Value = test statistic from the paired t-test comparing affected and non-affected limbs for each strength measure; p-Value = significance level of the test ($p < 0.05$ is considered statistically significant); Effect Size (Cohen's d) = magnitude of difference between limbs, with interpretation as follows: Small ($|d| < 0.3$), Medium ($|d| < 0.8$), Large ($|d| \geq 0.8$).

Discussion

This study aims to assess the potential effects of functional ankle instability (FAI) on static and dynamic balance, and functional performance among college students. The results reveal substantial differences between the affected limb with FAI and the unaffected limb.

Static balance

The single-leg stance (SLS) test findings showed that the affected limbs performed noticeably worse both with and without their eyes open. However, findings of SLS with closed eyes showed minimal difference when compared to normative data of healthy subjects[13] . These results are consistent with a previous study that found that FAI participants performed worse on SLS, especially while their eyes were closed[19]. This may be explained by delayed neuromuscular responses and proprioceptive abnormalities.

Dynamic balance (Y-balance Test)

The affected limbs had considerably lower Y-balance test scores (63.32% vs. 71.39%, p < 0.001) is statically significant. This finding comes from Gribble et al[20]. Who reported that FAI participants had decreased normalized reach distances on the Y-balance test, indicating compromised dynamic stability.

Functional performance (Side hop test)

This study showed significant effects of FAI on functional performance. Orakifar et al. suggested that the side hop test alone is insufficient for diagnosing or predicting specific deficits. They investigated this relationship and found no significant correlation between side hop test

performance and isometric strength of ankle muscles and agree with the current study especially side hop alone is not enough[21]. Despite the finding of significant functional and balance problems in this study, the underlying neuromuscular or biomechanical causes remain unexplored. We did not investigate the changed kinematics and delayed peroneal muscle activation that has been noted in FAI patients by prior research[22].

In order to reduce FAI-related deficiencies, Hale et al. (2014) suggested balance training therapies that emphasize proprioception and neuromuscular control[23]. The current research is compatible with the therapeutic application of these findings.

Strengths of the Study

This study employed several validated instruments, including the side hop test, Y-balance test, and single-leg stance test, to assess various aspects of functional performance and balance. Using different methods to produce an accurate assessment, and when using one of them alone is insufficient in assessment. The findings are more dependable and applicable. The impact of functional ankle instability (FAI) on balance and functional performance in young, active people, especially college students, is a crucial but little-studied topic. The literature on sports medicine and rehabilitation benefits from this approach. The results provide particular measurements and assessments that can target treatment options for people with FAI and are directly applicable to clinical and rehabilitative settings.

Limitations of the study

Thirty-eight individuals is a small sample size, which could limit generalizability which may limit how broadly it may be applied to other groups, and lacks longitudinal data, which could provide light on how FAI develops and how it affects people over time. The control group was taken from the opposite foot of the same patient, which is another limitation. To avoid the cross-over effect, control should be taken from a different normal individual.[24]. Further research should broaden to encompass a variety of demographics and carry out longitudinal analyses in order to comprehend the development of functional ankle instability (FAI) and the efficacy of rehabilitation techniques. Extensive biomechanical analysis may offer more profound insights into FAI-related deficiencies, whereas trials should assess focused therapies such as neuromuscular and balance training. Using wearable technology to provide real-time input and investigating the psychological effects, such as fear of reinjury, could improve treatment. Along with evaluating the financial cost of FAI, comparative studies between sports and school-based preventative initiatives are crucial in highlighting the significance of early intervention and prevention.

Conclusion

The study emphasizes the significant impact of functional ankle instability (FAI) on college students' balance and functional performance. The impacted limbs performed worse in balance tests, indicating deficiencies in balance and neuromuscular control. FAI impairs postural control and increases the risk of re-injury. The findings suggest future research should focus on different demographics, longitudinal studies, and intervention trials. Including biomechanical instruments and psychological aspects could improve understanding of FAI.

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References

1. Thompson, C., Schabrun, S., Romero, R., Bialocerkowski, A., van Dieen, J., Marshall, P.: Factors Contributing to Chronic Ankle Instability: A Systematic Review and Meta-Analysis of Systematic Reviews. 2018.

2. Al-Mohrej, O.A., Al-Kenani, N.S.: Chronic ankle instability: Current perspectives. Avicenna J Med.2016; 06:103–108.

3. Gribble, P.A., Bleakley, C.M., Caulfield, B.M., Docherty, C.L., Fourchet, F., Fong, D.T.P., Hertel, J., Hiller, C.E., Kaminski, T.W., McKeon, P.O., Refshauge, K.M., Verhagen, E.A., Vicenzino, B.T., Wikstrom, E.A., Delahunt, E.: 2016 consensus statement of the International Ankle Consortium: Prevalence, impact and long-term consequences of lateral ankle sprains. Br J Sports Med. 2016;50: 1493–1495.

4. Donovan, L., Hetzel, S., Laufenberg, C.R., McGuine, T.A.: Prevalence and Impact of Chronic

Ankle Instability in Adolescent Athletes. The Orthopaedic Journal of Sports Medicine. 2020; 8(2): 2325967119900962
5. Waterman, B.R., Owens, B.D., Davey, S., Zacchilli, M.A., Belmont, P.J.: The Epidemiology of Ankle Sprains in the United States. Journal of Bone and Joint Surgery. 2010; 92: 2279–2284 (2010).
6. HINTERMANN, B.: Biomechanics of the unstable ankle joint and clinical implications. Med Sci Sports Exercise. 1999; 31: S459–S469.
7. Santos, M.J., Liu, W.: Possible Factors Related to Functional Ankle Instability. Journal of Orthopaedic & Sports Physical Therapy. 2008; 38: 150–157.
8. Ha, S.-Y., Han, J.-H., Sung, Y.-H.: Effects of ankle strengthening exercise program on an unstable supporting surface on proprioception and balance in adults with functional ankle instability. J Exerc Rehabil. 2018; 14: 301–305.
9. Hertel, J.: by the National Athletic Traines. Association, Inc *Journal of Athletic Training* 2002;37(4):364–375.
10. Park, Y.H., Park, S.H., Kim, S.H., Choi, G.W., Kim, H.J.: Relationship Between Isokinetic Muscle Strength and Functional Tests in Chronic Ankle Instability. Journal of Foot and Ankle Surgery. 2019; 58: 1187–1191.
11. Holland, B., Needle, A.R., Battista, R.A., West, S.T., Christiana, R.W.: Physical activity levels among rural adolescents with a history of ankle sprain and chronic ankle instability. PLoS One. 2019; 14: e0216243.
12. Toyooka, T., Urabe, Y., Sugiura, S., Takata, A., Shinozaki, M., Takata, Y., Ishizaki, T., Nakamura, K., Otsuki, K., Oyama, T., Nishikawa, S.: Does the single-limb stance reflect chronic ankle instability in an athlete? Gait Posture. 2018; 66: 242–246.
13. Riemann, B.L., Ma, A., Guskiewicz, K.M.: Effects of Mild Head Injury on Postural Stability as Measured Through Clinical Balance Testing. Journal of Athletic Training 2000;35(1):19-25C
14. Shaffer, S.W., Teyhen, D.S., Lorenson, C.L., Warren, R.L., Koreerat, C.M., Straseske, C.A., Childs, J.D.: Y-Balance Test: A Reliability Study Involving Multiple Raters. Mil Med. 2013;178: 1264–1270.
15. Manoel, L.S., Xixirry, M.G., Soeira, T.P., Saad, M.C., Riberto, M.: Identification of Ankle Injury Risk Factors in Professional Soccer Players Through a Preseason Functional Assessment. Orthop J Sports Med. 2020; 8.
16. Gil-Martín, M., Johnston, W., San-Segundo, R., Caulfield, B.: Scoring Performance on the Y-Balance Test Using a Deep Learning Approach. Sensors. 2021; 21: 7110.
17. Kamonseki, D.H., Cedin, L., Tavares-Preto, J., Calixtre, L.B.: Reliability, validity, and minimal detectable change of Side Hop Test in male children and adolescents. Physical Therapy in Sport. 2018; 34:141–147.
18. Munteanu, S.E., Strawhorn, A.B., Landorf, K.B., Bird, A.R., Murley, G.S.: A weightbearing technique for the measurement of ankle joint dorsiflexion with the knee extended is reliable. J Sci Med Sport. 2009; 12: 54–59.
19. Docherty, C.L., Mcleod, T.C.V., Shultz, S.J.: Scoring System. Clinical Journal of Sports Medicine. 2006;16(3):203-8.
20. Gribble, P.A., Hertel, J., Plisky, P.: Using the Star Excursion Balance Test to Assess Dynamic Postural-Control Deficits and Outcomes in Lower Extremity Injury: A Literature and Systematic Review. J Athl Train. 2012; 47: 339–357.
21. Orakifar, N., Varehzardi, F., Mofateh, R., Seyedtabib, M.: Ability of Side Hop Test to Predict Deficits in Dynamic Balance Control and Isometric Strength of Hip and Ankle Muscles in Recreational Male Athletes with Chronic Ankle Instability. JRSR. 2025;12: 30–36.
22. O'Driscoll, J., Delahunt, E.: Neuromuscular training to enhance sensorimotor and functional deficits in subjects with chronic ankle instability: A systematic review and best evidence synthesis, (2011). sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology. 2011; 3:19.
23. Hale, S.A., Fergus, A., Axmacher, R., Kiser, K.: Bilateral Improvements in Lower Extremity Function After Unilateral Balance Training in Individuals with Chronic Ankle Instability. J Athl Train. 2014; 49: 181–191.
24. Farivar, M., Harris, S., Agana, A., & King, A. C. Lower Limb Cross-Over Effects on Postural Control: Impact of Proximal and Distal Muscle Fatigue. *Biomechanics*.2024; *4*(1): 50-62.