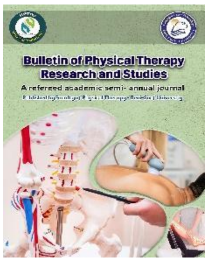
Bulletin of Physical Therapy Research and Studies

journal homepage: https://bptrs.journals.ekb.eg/

ISSN: 2636-4190



Correlation between Dynamic Trunk Muscle Endurance and Hamstring Flexibility in Patients with Chronic Ankle Instability

Maha Ahmed Saleh [1], Abdelgalil Allam Abdelgalil [2], Nasr Awad Abdelkader [3]

[1] Demonstrator, Department of Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Kafr El-Sheikh University, Egypt.

[2] Lecturer, Department of Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Cairo University, Giza, Egypt.

[3] Assistant Professor, Department of Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Cairo University, Giza, Egypt.

Corresponding author:

Maha Ahmed Saleh

Demonstrator, Department of Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Kafr El-Sheikh University, Egypt.

Email**: salehmaha01@gmail.com**

Tel: 01003021495

DOI: 10.21608/bptrs.2025.379030.1044

Running Title: Correlation between Dynamic Trunk Endurance and Hamstring Flexibility in Chronic Ankle Instability.

Abstract

[**Purpose**] This study was carried out to determine the relationship between dynamic trunk muscle endurance and hamstring flexibility in patients with chronic ankle instability (CAI). [**Methods**] A correlational study was conducted on twenty-nine non-athletic patients suffering from CAI of both sexes, with a mean age, weight, height, and BMI equal 22.24 ± 1.19 years, 74.69 ± 10.33 kg, 174.31 ± 8.82 cm, and 24.38 ± 2.24 kg/m², respectively were recruited for the study. Dynamic trunk muscle endurance and hamstring flexibility were assessed by bench trunk curl-up test and 90-90 active knee extension test, respectively. [**Results**] Correlation analysis of dynamic trunk muscle endurance and hamstring flexibility revealed a correlation coefficient $r=0.403$, $p = 0.03$; indicating there is statistically significant positive moderate correlation between the two variables. [**Conclusion**] According to the study's findings, A significant positive moderate correlation was identified between hamstring flexibility and dynamic trunk endurance in non-athletic patients with chronic ankle instability.

Keywords: Ankle Sprain, Trunk Endurance, Hamstring Flexibility, Chronic ankle Instability.

Introduction

Lateral ankle sprains represent a frequent category of musculoskeletal trauma affecting the distal segments of the lower limbs.[1] Following a lateral ankle sprain, chronic ankle instability (CAI) is estimated to occur in about 40% of affected individuals.[2] Chronic ankle instability is a state involving both functional and mechanical deficits, characterized by a range of functional deficits that predispose individuals to recurrent ankle sprains, the sensation of the ankle "giving way" and subjective experience of instability.[3,4,5,6]

Core stability is considered a crucial element for preserving dynamic joint stability within the foot-to-lumbar spine kinetic chain.[7,8]It is pertinent to clarify that, within this context, core stability is one of the most important factors that denotes the capacity of the hip complex to maintain equilibrium in response to perturbation and to resist involuntary flexion or collapse. Furthermore, empirical evidence demonstrably links the movement of the lower limbs to the activation of trunk musculature.[9] Dysfunction within the trunk, pelvis, and hips can initiate disruptions in the motor chain, subsequently contributing to the occurrence of lower extremity injuries and lower back pain (LBP).[10]

Motor control and dynamic trunk endurance are fundamentally linked in supporting physical function, especially for activities requiring stability and coordination. Neurological control of movement necessitates the sustained capacity of trunk muscles, as diminished endurance can lead to fatigue, altered movement patterns, and increased injury risk, thereby impairing motor control. Studies have shown that improving trunk muscle endurance enhances postural adjustments and balance.[11,12]

Beyond conditions such as low back discomfort and irregular gait, hamstring tightness is associated with functional impairments in the lumbar spine, pelvis, and lower limb.[13]Limitations in hamstring flexibility are associated with altered motor control, particularly in the lumbopelvic area. Reduced hamstring extensibility often leads to a compensatory increase in their stabilizing role, potentially due to underactive core muscles. This shift away from their primary function as hip and knee extensors can result in overuse and tightness. Impaired motor control also affects the activation of postural muscles, increasing reliance on the hamstrings for stability. Fatima et al. [14]suggest prolonged sitting contributes to this issue by limiting hamstring use. Conversely, Loutsch et al. [15]found that restoring proper muscle activation through neuromuscular reeducation improves hamstring flexibility, indicating the importance of motor control. Therefore, the purpose of this study was to determine the relationship between dynamic trunk muscle endurance and hamstring flexibility in patients with chronic ankle instability.

Methods

This study was designed as a correlational study that included twenty-nine non-athletic patients with unilateral CAI. The study was conducted at the out-patient clinic, Faculty of Physical Therapy, Kafr El-Sheikh University and an informed consent form was signed by each patient before participating in the study. Ethical approval was obtained from the institutional review board of Faculty of Physical Therapy, Cairo University before study commencement (No: P.T.REC/012/005526).

The recruited patients were included based on the following inclusion criteria: non- athletics diagnosed with CAI, with age rang 20-35 years (male & female), had history of multiple giving way and/or recurrent sprain, and/or "feelings of instability, and Cumberland Ankle Instability Tool (CAIT) patient scores < 24. Patients were excluded if they had any of the following: history of previous ankle surgery, lower back pain, or ankle fractures. The duration of this study was 5 months from November 2024 till March 2025.

Assessment procedures

Active Knee Extension test

The 90-90 Active Knee Extension (AKE) test is the most frequently employed method for the assessment of hamstring flexibility. The AKE test is often cited as the criterion standard for evaluating hamstring flexibility due to its simplicity, reliability, and affordability. This assessment involves an active extension movement at the knee joint while maintaining 90° of hip flexion.[16] To start the test, patients were instructed to assume a supine position on the examination table. To mitigate compensatory movements, the contralateral limb remained in a fully extended position at the knee and was secured with a strap across the mid-thigh. Additionally, pelvic stabilization was achieved through the application of a strap around the pelvic girdle. (Figure 1). A wooden frame was aligned with the patient's anterior superior iliac spine on the plinth to ensure the hip joint was maintained at a 90-degree angle. Throughout the assessment, patients were instructed to flex their tested leg until the thigh contacted the wooden frame. Hamstring muscle flexibility was quantified by measuring the degree of knee extension using a standard, double-arm, full circle transparent plastic goniometer. The goniometer's axis was aligned with the lateral knee joint line, with the stationary arm positioned parallel to the femur and the mobile arm oriented towards the lateral malleolus of the ankle. Subsequently, without prior warm-up, patients were instructed to maximally extend their knees while maintaining thigh contact with the wooden apparatus, as shown in (Figure 1). Three measurements were recorded after one practice trial. The average of these goniometer readings served as the indicator of hamstring flexibility, with a one-minute rest between each measurement.[17,18]

Figure (1): (A) start position (B) end position 90-90 Active Knee Extension Test

Dynamic Endurance Test:

Bench Trunk Curl-Up test

The McGill trunk endurance tests, recognized for their high validity and reliability, were employed to assess trunk muscle endurance of patients positioned supine on a bench, with their hips and knees maintained at a 90-degree flexion angle (ankles rested on a stool), a measurement confirmed using an extendable goniometer. Their arms were crossed, with each hand grasping the opposite elbow. (Figure 2). Starting in the described supine position, patients performed trunk curl-ups until their elbows touched their thighs, their scapulae lifted off the mat, and their heads remained neutral, then returned to the start. To isolate trunk flexion and prevent hip/lower back flexion (sit-up), patients asked to move trunk until crossed elbow touch the supported thighs on used stool. The test measured the maximum correctly performed repetitions within two minutes. Correct repetitions, where the head touched the mat on the return and elbows touched thighs on flexion, were recorded.[19]

Figure (2): (A) start position (B) end position Bench Trunk Curl-Up test

Statistical Analysis

Descriptive statistics were employed to show the demographic information and data collected from the patients. The Shapiro-Wilk test was conducted to determine whether the data follows a normal distribution. To assess the relationship between hamstring flexibility and dynamic trunk muscle endurance, the Pearson Correlation Coefficient was utilized. A significant level of $p \leq 0.05$ was established for all statistical tests. The analysis was carried out using version 27 of the Statistical Package for Social Sciences (SPSS) for Windows.

Results

A total of twenty-nine non-athletic patients suffering from CAI were recruited for the study. Detailed demographic data of the patients can be found in table 1. A significant positive moderate correlation was identified between hamstring flexibility and dynamic trunk endurance ($r = 0.403$, $p = 0.030$) (Table 2 and figure 3).

Table 1: patient characteristics

	Minimum	Maximum	Mean ± SD
Age years	21	25	22.24±1.19
Height(cm)	150	185	174.31± 8.82
Weight(kg)	50	94	74.69± 10.33
BMI (kg/m2)	20	28	24.38± 2.24
		N (%)	
Female		9(31%)	
Male		20(69%)	
Right		15(52%)	
Left		14(48%)	

N, Number; SD, Standard deviation

Table 2. Correlation between Hamstring flexibility and dynamic trunk endurance (Bench Trunk Curl-Up test)

Variables	Hamstring Flexibility (degrees)		
	R-value	P-value	95% CI
Bench Trunk Curl-Up test(repetitions)	0.403*	0.030	(0.043- 0.671)

r value: Pearson correlation; p value: Probability value, CI: confidence interval, * significant at p ≤ 0.05.

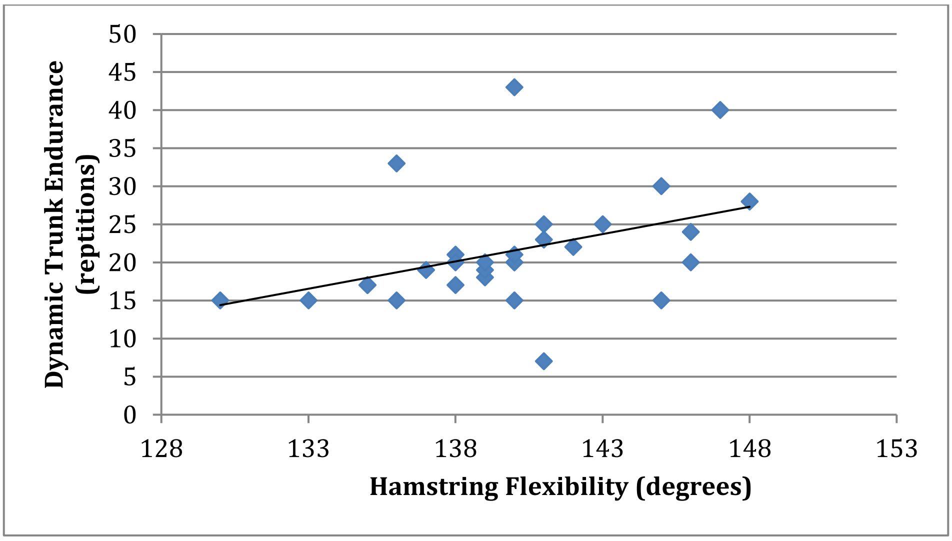


Figure (3): Scatter plot of the relationship between dynamic trunk endurance (Bench Trunk Curl-Up test) and hamstring flexibility

Discussion

The current study was conducted to investigate the correlation between dynamic trunk muscle endurance and hamstring flexibility in non-athletic patients with CAI. A statistically significant positive correlation of moderate magnitude was observed in this study between hamstring flexibility and dynamic trunk endurance in non-athletic patients with CAI. This finding implies that increased hamstring flexibility may be associated with improved control and endurance of the trunk musculature within this population. This relationship could be attributed to the integrated biomechanical function of the posterior kinetic chain, which plays a critical role in both postural control and dynamic movement.[20] Core stability is a recognized critical element in maintaining neuromuscular control and relieving the risk of lower limb injuries, especially in patients with CAI.[21]Deficiencies in dynamic trunk endurance can lead to compromised balance and the adoption of compensatory movement patterns, potentially increasing mechanical load on the ankle joint.[22]Furthermore, restricted hamstring flexibility may contribute to alterations in pelvic alignment and a decrease in the effective activation of trunk musculature.[23]The interaction of these factors may provide an explanation for the observed correlation between hamstring flexibility and trunk endurance in this population. Previous study assessed hamstring flexibility in ankle sprain or CAI and concluded that CAI patients have proximal muscular affection including hamstring tightness which may alter sacroiliac joint stability and subsequently back pain.[24] While this highlights the role of the hamstrings in postural and pelvic control, the specific interaction between hamstring tightness and dynamic trunk endurance has often been overlooked. This relationship is essential, as hamstring tightness can lead to compensatory overactivation and reduced flexibility, thereby limiting the functional contribution of the core muscles in trunk stabilization. A recent study by Kapre and Alexander (2024) further supports this connection, finding a significant correlation between weak core muscles and reduced hamstring flexibility in young adults, suggesting a reciprocal neuromuscular relationship between these muscle groups.[25]In individuals with CAI, impaired core endurance may exacerbate hamstring tightness by increasing reliance on the hamstrings for postural support, potentially destabilizing the SIJ and reducing movement efficiency. Therefore, addressing dynamic trunk endurance alongside flexibility is crucial in understanding and treating the proximal effects of CAI. The findings of the current study investigate the correlation between dynamic trunk muscle endurance and hamstring flexibility in non-athletic patients with CAI support the concept that reasonable rehabilitation protocols for CAI should adopt a comprehensive perspective, addressing not only the affected ankle joint but also proximal elements including core strength and the flexibility of the posterior kinetic chain. Therapeutic interventions incorporating hamstring stretching and core endurance exercises may potentially lead to improved functional outcomes and a reduction in the recurrence of instability-related symptoms.[26] Future research efforts should investigate whether therapeutic interventions designed to enhance hamstring flexibility and dynamic trunk endurance can yield clinically meaningful improvements in patients diagnosed with CAI.

Conclusion

According to the study's findings, A significant and positive moderate correlation was identified between hamstring flexibility and dynamic trunk endurance in patients with CAI. This finding highlights the potential interdependence between posterior chain flexibility and core endurance in maintaining functional stability. It suggests that rehabilitation strategies for CAI should not focus solely on the ankle joint but also incorporate interventions aimed at improving hamstring flexibility and trunk endurance to enhance overall neuromuscular control and reduce the risk of recurrent instability.

Limitations of the study

The limited sample size (n=29) of non-athletes represents a key constraint, potentially compromising the generalizability of the findings to broader populations, especially athletes with potentially different neuromuscular patterns. While both sexes were included, the lack of sex-specific analysis means that potential gender-related differences in hamstring flexibility and trunk endurance and their impact on the correlation were not examined. Moreover, the cross-sectional design prevents the determination of causality. The study's small sample size also increases the risk of type II errors and may have inflated the observed correlation coefficient due to sampling variability.[27]

No funding.

No conflict of interest.

References

1) Spennacchio P, Meyer C, Karlsson J, Seil R, Mouton C, Senorski EH. Evaluation modalities for the anatomical repair of chronic ankle instability. Knee Surg Sports Traumatol Arthrosc. 2020;28(1):163-176.
2) Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med. 2014;44(1):123-140.
3) Gribble PA, Bleakley CM, Caulfield BM, et al. Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. Br J Sports Med. 2016;50(24):1496-1505.
4) Gribble PA, Delahunt E, Bleakley C, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. J Orthop Sports Phys Ther. 2013;43(8):585-591.
5) Cao, S., Wang, C., Zhang, G., Ma, X., Wang, X., Huang, J., Zhang, C., & Wang, K. (2019). In vivo kinematics of functional ankle instability patients during the stance phase of walking. Gait & posture, 73, 262–268.
6) Ha, S. Y., Han, J. H., & Sung, Y. H. (2018). Effects of ankle strengthening exercise program on an unstable supporting surface on proprioception and balance in adults with functional ankle instability. Journal of exercise rehabilitation, 14(2), 301–305.

7) Akuthota, V, Nadler SF. (2004). Core strengthening. Arch Phys Med Rehabil.;85(suppl 1): S86–S92.
8) Zazulak, B, Cholewicki J, Reeves NP (2008). Neuromuscular control of trunk stability: clinical implications for sports injury prevention. J Am Acad Orthop Surg.;16(9):497–505.
9) Willson, J. D., Dougherty, C. P., Ireland, M. L., & Davis, I. M. (2005). Core stability and its relationship to lower extremity function and injury. The Journal of the American Academy of Orthopaedic Surgeons, 13(5), 316–325.
10) Seidenberg, P, Bowen J, King D (2017): The hips and pelvis in sports medicine and primary care. Springer.
11) De Los Ríos-Calonge J, Barbado D, Prat-Luri A, Juan-Recio C, Heredia-Elvar JR, Elvira JLL, et al. Are trunk stability and endurance determinant factors for whole-body dynamic balance in physically active young males? A multidimensional analysis. Scand J Med Sci Sports. 2024;34(3):e14588.
12) Stotz A, Mason J, Groll A, Zech A. Which trunk muscle parameter is the best predictor for physical function in older adults? Heliyon. 2023;9(10):e20123.
13) Hopper, D, Deacon S, Das S, Jain A, Riddell D, Hall T, Briffa K (2004). Dynamic soft tissue mobilization increases hamstring flexibility in healthy male subjects. Br J Sports Med. 2005, 39:594-8. 10.1136/bjsm.2004.011981.
14) Fatima, G, Qamar MM, Hassan JU, Basharat A (2017). Extended sitting can cause hamstring tightness. Saudi J Sports Med. 2017, 17:110-4. 10.4103/sjsm.sjsm_5_17.
15) Loutsch, RA, Baker RT, May JM, Nasypany AM (2015). Reactive neuromuscular training results in immediate and long-term improvements in measures of hamstring flexibility: A case report. Int J Sports Phys Ther., 10:371-7.
16) Connor, S. O., McCaffrey, N., Whyte, E., & Moran, K. (2015). Reliability of a modified active knee extension test for assessment of hamstring flexibility. International Journal of Athletic Therapy and Training, 20(4), 32-36.
17) Lee, D. K., & Oh, J. S. (2018). Relationship between hamstring length and gluteus maximus strength with and without normalization. Journal of physical therapy science, 30(1), 116-118.
18) Sokran, S. N. B. B. M., Rogini, A., Periasamy, P., & Paul, J. (2019). Inter-rater and Intra-rater reliability between experience and non-experienced examiners on 90-90 active knee extension test using Goniometer among healthy college students. ijmaes, 5(3), 586-593.

19) Knudson, D. (2001). The validity of recent curl-up tests in young adults. *The Journal of Strength & Conditioning Research*, *15*(1), 81-85.

20) Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. Sports Med. 2006;36(3):189–98.

21) Hoch MC, Staton GS, McKeon PO. Diminished sural nerve function contributes to balance impairments in patients with chronic ankle instability. Clin Neurophysiol. 2012;123(9):1696–701.

22) Gribble PA, 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. 2004;39(3):304–11.

23) Dannelly BD, Otey SC, Croy T, Harrison B, Rynders CA, Hertel J. The effectiveness of a closed chain stretching program on hamstring flexibility and lower extremity performance. J Strength Cond Res. 2006;20(2):299–304.

24) Tahoon, A., Shendy, S., El-khozamy, H., & Baky, W. A. (2019). Flexibility deficit in chronic ankle instability. *Case Medical Research*.

25) Kapre TM, Alexander JO. A correlation study of weak core muscles with hamstring muscles flexibility in young adults. Bulletin of Faculty of Physical Therapy. 2024 Nov 12;29(1):79.

26) Olmsted LC, Carcia CR, Hertel J, Shultz SJ. Efficacy of the Star Excursion Balance Tests in detecting reach deficits in subjects with chronic ankle instability. J Athl Train. 2002;37(4):501–6.

27) Button KS, Ioannidis JP, Mokrysz C, Nosek BA, Flint J, Robinson ES, et al. Power failure: why small sample size undermines the reliability of neuroscience. Nat Rev Neurosci. 2013;14(5):365-376.