International Journal of Natural Medicine and Health Sciences
ISSN (Online):2790-2471 ISSN (Print): 2790-2463
Volume 2(1) December 2022
Journal homepage: https://journals.iub.edu.pk/index.php/ijnms

Original Research

Comparison of dynamic balance between flat feet and normal athletes

Umair Rauf [a], Muhammad Adnan[b], Abdullah[c*], Noman Sadiq[d]

[a] Department of Physical Therapy, NCS Institute of Sciences Capital Campus, Islamabad, Pakistan.
[b] Khyber Teaching Hospital, Peshawar, Pakistan.
[c*] Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Phaya Thai Rd, Pathum Wan, Bangkok 10330.
[d] Riphah International University, Islamabad, Pakistan.

Article Info.

Received: 04-10-2022
Revised: 28-11-2022
Accepted: 30-11-2022
Online: 31-12-2022

Correspondence:
abdullahkhanmd12@gmail.com

Keywords: Flatfeet, Foot Pronation, Navicular Drop, SEBT

open access

Copyright (c) 2021, International Journal of Natural Medicine and Health Sciences licensed under Creative Commons Attribution-Non-Commercial 4.0 International License.

Abstract

Objectives: This study aimed to compare the dynamic balance between flat feet and normal athletes using Star Excursion Balance Test (SEBT). Research Design: This was a Cross-sectional comparative study. Method: Total 58 athletes, 29 subjects with flat feet (assessed by Sit to Stand Navicular Drop Test) and 29 subjects with normal feet were selected. Both male and female athletes of age group 18-30 years were included. Sit to Stand Navicular Drop Test, Calcaneum Angle, the width of the foot, great toe extension range of motion and Stat Excursion Balance Test (SEBT) were the outcomes that were assessed in the study. Data analysis: Unpaired t-test using the Graph Pad Instat software system was used. Results: Significant mean differences in Sit to Stand Navicular Drop Test, Calcaneum Angle, the width of the foot, great toe extension range of motion, and SEBT were found in individuals with flat feet. The SEBT scores of normal arched feet (right leg: 75.50.2, left leg: 75.10.4) and flat feet (right: 78.12.3, left: 79.93.2) differed (p=0.001). The SEBT leg difference scores of subjects with flat feet (4.43.5) and normal arches (2.30.5) differed (p=0.001). Furthermore, the lateral excursion distance was the least in these individuals ($p<0.0001$). Conclusion: In flat feet individuals' Dynamic Balance is compromised as compared to normal arched feet.

Citation: Rauf U, Adnan M, Abdullah, Sadiq N. Comparison of Dynamic Balance between Flat Feet and Normal Athletes. IJNMS. 2022; 2(1)56-60.

Introduction: The foot is among the most important structure in the lower extremity that distributes weight during stance and gait-providing balance to the body. The foot serves as a silent, minute foundation of support-particularly in a single-leg stance for maintaining the balance of the body [1]. Any problem with the foot's strength, flexibility, or responsiveness affects the foot's capacity to stabilize the body and maintain its balance and may also be predisposed to injury. The stability of the entire body is compromised when there is any abnormality in the arches [2].

The medial longitudinal, transverse, and lateral longitudinal arches of the foot are important structures useful in shock absorption and help in maintaining stability during standing and walking. The ligaments, muscles, and plantar fascia support these three arches. People with flat feet besides improper foot load transmission exhibit importations in the lumbar areas and other joints including the knee and hip joints. The function of the foot structure includes weight carrying, shock absorption, balancing, and protection [3].

Flat feet, also known as fallen arches or pes planus, are due to the low medial longitudinal arch which lowers the entire foot's sole making partial or complete contact with the ground. Some people in the general population, which is thought to be between 20 and 30 percent, may not have completely developed arches in either one foot (unilateral) or both feet (bilateral). The structure of the arch in the foot and the biomechanics of the lower leg are interrelated. The arch creates a flexible and elastic link between the forefoot and the backfoot [4]. Pronation occurs in flat feet and the instability brought up by flat feet may interfere with the lower extremities' kinematic chain and induce biomechanical problems that make it difficult for the foot to maintain body balance [5]. The main assessment techniques used for flat feet assessment are: Resting calcaneal stance position angle (RCSP), Navicular drop test (ND), and medial longitudinal arch angle- which are anthropometric measurements. The Navicular drop test identifies pronated, normal, and supinated foot groups based on the medial transverse arch. Foot pronation is caused by the condensed height of the medial longitudinal arch, which also contributes to reduced weight distribution in both static and dynamic phases, resulting in foot pain and diminished lower extremity function [6].

A low medial longitudinal arch is a morphological trait of flat feet in a weight-bearing position. Low arches lead to mechanical imbalances such as tibialis posterior tendon problems, pains, joint injuries, and even stress fractures. Sharma et al. concluded that the running efficiency of flat feet athletes was less as compared to normal athletes [7]. According to Piskey et al., there is a significant difference between the anterior right and left reach distances during SEBT [8]. Medial Tibial Stress Syndrome (MTSS) is a specific injury that results in pain, the injury rate for MTSS was found to be 5%–15%, whereas the injury rate for athletes was 2.8 per 1000 hours. The risk of MTSS and the Navicular Drop Test (ND) is also increased by excessive clinical foot pronation [9].

The Star Excursion Balance Test (SEBT) is a handy evaluation technique that highlights an athlete's dynamic control of their postural system. It has been proven that applying SEBT to rehabilitating lower limb musculoskeletal injuries and contracting the lower extremity to recruit the musculature are both beneficial [10] The benefit of assessment of dynamic postural control is that in addition to remaining steady and upright more proprioception demands, strength and also needed Range of Motion (ROM) [11].In the geriatric and pediatric population, for the assessment of Dynamic postural control, a lot of tests have been developed [12] .A very effective assessment that gives a noteworthy dare to an athlete's dynamic control of the postural system is the Star Excursion Balance Test (SEBT) [13]. The mechanism of the Star Excursion Balance Test is the maintenance of base support by an individual with one leg and reaching the maximum point in diverse directions with an opposed leg making no compromise on the base support of the stance leg. SEBT along with the reliability that is intra-rater for measurements was demonstrated by Kinzey and Armstrong [14]. For deficits functions related to injuries that are musculoskeletal in nature a sensitivity in screening has been shown by SEBT [15]. In patients with chronic ankle instability, a decrease in reaching distances occurs while performing SEBT in comparison with healthy controlled participants [16]. For the assessment of dynamic postural control, a valid and most reliable instrument is SEBT [17]. Knowing the effect of flat feet on body posture and biomechanics, the implication of flat feet on balance have received little attention in literature. Hence the primary goal of this study was to assess the dynamic balance of athletes of both sexes with flat feet and those with normal arches using a variety of methodologies, particularly SEBT for accurate measurement to determine whether flat feet affect the dynamic balance or not. The secondary purpose was to determine different techniques that better evaluate the dynamic balance of flat feet and normal-arched athletes.

Methods: A comparative cross-sectional study design was used in this study. For this study, the subjects were selected by using a convenient sampling technique. The study was conducted in The Pakistan Sports Board and lasted for six months after clearance approval was issued by The Pakistan Sports Board. Male and female athletes with flexible flat feet and, normal arched, feet age groups ranging from 18 to 30, were examined in this study. Participants with a Body Mass Index (BMI) of more than 30, symptomatic inflexible flat feet, flexible flat feet with neuromuscular damage, a history of lower limb injury or cure, any other congenital anomaly linked with the condition, and limb length disparity were excluded from the study.

The following tools were used during the study for the assessment of the athletes: Sit to Stand Navicular Drop Test (SSNDT) for the diagnosis of flat feet, Measurement of Calcaneum Angle (CA), Measurement of Great Toe Extension, Balance test for the single leg, and Star Excursion Balance Test (SEBT). An unpaired t-test [TA1] with SEBT was applied for comparing dynamic balance among normal individuals and flatfeet. In individuals with flatfeet, a significant Mean Difference was found in the "Sit-to-Stand Navicular Drop Test, foot width, calcaneus angle, Range Of Motion (ROM), Great Toe Extension, and Star Excursion Balance Test". The length of the lateral excursion was also less in these individuals ($p<0.0001$).

Results: A total of 58 athletes aged between 18 and 30 were included in this study, 48 male (83%) and 10 female (17%). Out of 58 athletes, 29 had flat feet and 29 had normal arches. All participants in the control and experimental groups underwent a battery of examinations, including the SSNDT, the Navicular Drop Test, and the great toe ROM, besides having their ages, heights, and limb lengths measured. Most of the athletes were cricket players (63%) and almost half (48%) players were playing for the last one and a half years (Figures 1 & 2). The subjects were put through SEBT, which involved them moving barefoot in all 8 directions in three rounds for each foot, right and left. All the rounds were reviewed and recorded. The average distance for each direction for each foot was then calculated using the formula: Reach 1 + Reach 2 + Reach 3 / 3 gives the average distance in each direction (in cm).

At first measures in all directions were recorded in three rounds. Then the average distance in each direction was measured by the above-given formula. For each leg 8 values were obtained and a total of 16 values at the end while performing SEBT. The normalized relative distance in each direction was then measured by the formula: average distance in each direction/ leg length ×100. The difference in normalized relative distance between the left and right leg was measured and recorded. These measurements showed that the values of control group individuals were <4cm which showed that the dynamic balance of individuals in this group is correct. But the difference in normalized relative distance for those in the control group was >4 cm, increasing the risk of injury 2.5 times more. Then, a correlation and analysis of the mean difference and standard deviation among the experimental and control groups were performed. For the right leg, the mean difference and standard deviation of people with typical arched feet (75.5±0.2) were lower than those of athletes with flat feet (78.1±2.3). For flat feet, the left leg's mean difference and standard deviation were likewise large. The difference in the SEBT was 4.4±3.5, indicating that these people are 2.5 times more likely to sustain an injury than people with normal arched feet (2.3±0.53) (Table 1). A measurement of the linear correlation between two sets of data is the Pearson correlation coefficient (r). The correlation coefficient lies between +1 and -1. Because both variables tend to move in the same direction, the Pearson correlation values for the right leg (0.624) and left leg (0.67) of the current study revealed that the correlation was linear and positive (Table 2).

The findings showed that people with flat feet had altered dynamic balance. The inability of athletes to conduct sports activities is caused by flaws in their dynamic balance. To combat this instability proper exercise techniques should be followed to enhance athletes' performance and dynamic balance.

Discussion: The primary purpose of the study was to examine the comparison between flat feet and dynamic balance. The secondary purpose of the study was to explore evaluation techniques that are best in finding whether flat feet have an impact on the dynamic balance of athletes are not. We hypothesized that there would be no difference in the dynamic balance of flat feet and normal arched athletes. Our findings contradict the hypothesis as there exists a great difference in the dynamic balance of flat feet and normal arched athletes. It was hypothesized in this study that flat feet have no effect on the dynamic balance of athletes, but the results showed that there exists a great difference in the dynamic balance of flat feet and normal-arched athletes.

Athletes with flat feet have a greater calcaneus angle, which indicates their feet' pronation. The primary clinical sign of pronation, the medial longitudinal arch of the foot looks flattened in flat feet as a result of the foot rolling inward to make contact with the floor and support the body's weight. The calcaneus is in the valgus position, and the external rotation of the tibia and talus points medially downward. There could also be mid-foot sag because of the navicular's dorsal subluxation on the talus. The width of the foot is also wider in athletes with flatfeet. The intermetatarsal ligament is soft and lax, which allows the foot to expand and is the cause of the forefoot's splaying. With foot pronation the longitudinal arch downfalls along with the transverse arch. The metatarsal heads spread as a result of this alignment of the heads. The performance of flatfeet athletes is lower than that of normal arched-feet athletes because their dynamic balance is compromised.

A comparison between the results of our study to previous literature shows similarities of results with ours. A study conducted by Dabholkar A (2012) [6] showed the same results as our study. Dabholkar A. compared 30 subjects with bilateral flexible flat feet as assessed by sit-to-stand navicular drop test and 30 subjects with normal feet both in the age group 18-25 years were chosen for the study. The outcome assessed were sit-to-stand navicular drop test, calcaneum angle, width of the foot, great toe extension range of motion and SEBT. Extremely significant mean differences in sit-to-stand navicular drop test, calcaneum angle, width of the foot, great toe extension, range of motion and SEBT was found in individuals with flat feet. Also, the lateral excursion distance was the least in these individuals ($p<0.0001$).

Another study conducted by Ali (2011)[18] showed that there were significant differences ($P < 0.05$) between groups in favor to normal arched athletes where overall stability index ($t = 3.25$, $P = 0.004$), anterior-posterior stability index ($t = 2.95$, $P = 0.007$) and medial-lateral stability index ($t = 2.81$, $P = 0.010$) of athletes' single leg test and overall stability index of fall risk test ($t = 3.59$, $P = 0.001$). There was a poorer dynamic balance in the flexible flatfoot than the normal arched athletes in this study. But contrary to all these results and findings a study conducted in the year 2009 by Tudor [19] showed that individuals with flat feet and normal arched feet show similar contributions in athletic activities and there is no difference in the performance of both. In the accomplishment of all motor tests, it was assessed that both types of individuals show the same results. So, on these findings, it was then recommended that there is no need for treatment for flexible flat feet to improve athletic performance.

There is a significant correlation between our study and the results of Prvulovic (2021) [20] and our study showed that the most common foot deformity found among athletes is flat feet (pes planus). It is clear from the literature that different lower limb deformities have a significant effect on athletes' performance especially the foot which plays an important role in many sports. Studies have revealed that time and reaction speed while performing motor tasks was high for players having normal feet as compared to athletes with flat feet.

The findings of this study were correlated with the findings of A. Tiaotrakul (2021) [21] whose results showed that flat feet occurred in almost sports activities namely, volleyball, basketball, Karatedo, futsal, and taekwondo. The BMI of all athletes was in the normal range, except for Karatedo athletes. Most athletes reported high physical activities level Pearson correlation analysis revealed that gender was positively associated with flat feet. Studies of Dabholkar (2012), Ali (2011), Prvulovic (2021), Tiaotrakul (2021), and present-day studies showing similar results. According to Dabholkar, athletes with flat feet poorly performed athletic activities compared to normal arched feet and Prvulovic examined that different deformities in the lower limb have a significant effect on athletes' performance. Similarly, Ali reported that dynamic balance is compromised in athletes having flat feet. The results of the present study also revealed that flat feet individuals were unable to perform athletic activities as their dynamic balance was damaged and were not in a position to perform SEBT accurately. The results were in contrast to the study of Tudor who showed that there is no difference in the performance with flat feet and normal arched in athletic activities. The reason for the similarity of results with the results of Dabholkar, Ali, Prvulovic and Tiaotrakul was that flat feet affect the performance of individuals in athletic activities and are considered more prone to injury.

Conclusion: Athletes with flat faces have more difficulty maintaining their balance than athletes with normal feet. The results of the current study also suggest that flat feet may increase the risk of developing bunions and Achilles tendonitis as well as other musculoskeletal issues such as plantar fasciitis and ankle sprain. Thus, treating or correcting the flat feet issue is crucial for the person with flat feet to enhance their balance to avoid long-term difficulties and other musculoskeletal ailments.

Limitations: In the study, the proportion of women (16.7%) is lower than that of men (83.3%).

Recommendations: The investigation revealed that Flat feet have a great impact on the dynamic balance of athletes. On this basis, future studies should examine athletes for flat feet below the age group of 18 in both sexes and find out other techniques that best examine athletic performance so that they overcome this deformity and perform well in all athletic activities.

References

1. Moon D-c, Kim K, Lee S-k. The immediate effect of short-foot exercise on the dynamic balance of subjects with excessively pronated feet. *J Phys Ther Sci*. 2014;26(1):117-9.
2. Kim J-a, Lim O-b, Yi C-h. The difference in static and dynamic stability between flexible flatfeet and neutral feet. *Gait & posture*. 2015;41(2):546-50.
3. Takata Y, Matsuoka S, Okumura N, et al,. Standing balance on the ground—the influence of flatfeet and insoles. *J Phys Ther Sci*. 2013;25(12):1519-21.
4. Sivachandiran S, Kumar G. Effect of corrective exercises program among athletes with flat feet on foot alignment factors. *International Journal of Physical Education, Sports, and Health*. 2016;3(6):193-6.l
5. Stade M, Fotrousi F, Seyff N, et al,. Feedback gathering from an industrial point of view. *IEEE 25th International Requirements Engineering Conference (RE);* 2017: IEEE
6. Dabholkar A, Shah A, Yardi S. Comparison of dynamic balance between flat feet and normal individuals using star excursion balance test. *Indian Journal of Physiotherapy and Occupational Therapy*. 2012;6(3):33-7.
7. Kulthanan T, Techakampuch S, Donphongam N. A study of footprints in athletes and non-athletic people. *Journal-Medical Association Of Thailand*. 2004;87(7):788-93.
8. Plisky PJ, Gorman PP, Butler RJ, et al. Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. *North American journal of sports physical therapy: NAJSPT*. 2009;4(2):92.
9. Hunt AE, Smith RM, Torode M, et al. Inter-segment foot motion and ground reaction forces over the stance phase of walking. *Clinical biomechanics*. 2001;16(7):592-600.
10. Eltoukhy M, Kuenze C, Oh J, et al,. Kinect-based assessment of lower limb kinematics and dynamic postural control during the star excursion balance test. *Gait & posture.* 2017; 58:421-7.
11. Donahoe B, Turner D, Worrell T. The use of functional reach as a measurement of balance in boys and girls without disabilities ages 5 to 15 years. *Pediatric Physical Therapy*. 1994;6(4):189-93.
12. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Canadian journal of public health= Revue canadienne de sante publique*. 1992;83: S7-11.
13. Earl JE, Hertel J. Lower-extremity muscle activation during the Star Excursion Balance Kinzey SJ, Armstrong CW. The reliability of the star-excursion test in assessing dynamic balance. *Journal of orthopaedic & sports physical therapy*. 1998;27(5):356- 60.
14. Kinzey SJ, Armstrong CW. The reliability of the star-excursion test in assessing dynamic balance*. Journal of orthopaedic & sports physical therapy*. 1998;27(5):356- 60
15. Miller III SJ. A biomechanical analysis of the anterior balance reach test: *The Pennsylvania State University*; 2001.
16. Ganesh GS, Chhabra D, Mrityunjay K. Efficacy of the star excursion balance test in detecting reach deficits in subjects with chronic low back pain. Physiotherapy *Research International*. 2015;20(1):9-15. *Tests. Journal of Sport Rehabilitation.* 2001;10(2):93-104.
17. Gray GW. Lower extremity functional profile: Wynn Marketing, Incorporated; 1995.
18. Ali M.I. & Eldien M.S. "Dynamic Postural Balance in Subjects with and without Flat Foot" Department of Physical Therapy for Musculoskeletal Disorders, Faculty of Physical Therapy, Cairo University. *Bull. Fac. Ph. Th. Cairo Univ.,* Vol. 16, No. (1) Jan. 2011
19. Tudor A, Ruzic L, Sestan B, Sirola L, Prpić T. Flat-footedness is not a disadvantage for athletic performance in children aged 11 to 15 years. *Pediatrics.* 2009;123(3):e386-e92.
20. Prvulović N, Lilić A, Hadžović M. The prevalence of foot deformities in athletes with various sports backgrounds. *Facta Universitatis Series: Physical Education and Sport.* 2021:667-79.
21. Tiaotrakul A, Jaruchart T, Jangthong P, et al,. The prevalence and relationship between flatfoot and related factors among university athletes. *Journal of Sports Science and Health.* 2021;22(1):86-102.

Table. 1. SEBT Score Difference between flat feet and normal athlete.

Sr/No.	Variables	Mean ±SD		p-value	Pearson Correlation (r)
		Group-A Flatfeet	Group-B Normal feet		
1	SEBT Score Difference	4.4±3.5	2.3±0.53	0.00	0.80

*P-value is extremely significant.

Table. 2. Excursion Distance of Normal Arched Feet versus Flat Feet:

Sr/No.	Variable	Mean ±SD		p-value	Pearson correlation (r)
		Group-A Flatfeet	Group-B Normal feet		
1.	Right leg SEBT	75.5±2.3	78.1±0.2	0.00	0.624
2.	Left leg SEBT	79.9±3.2	75.1±0.4	0.00	0.67

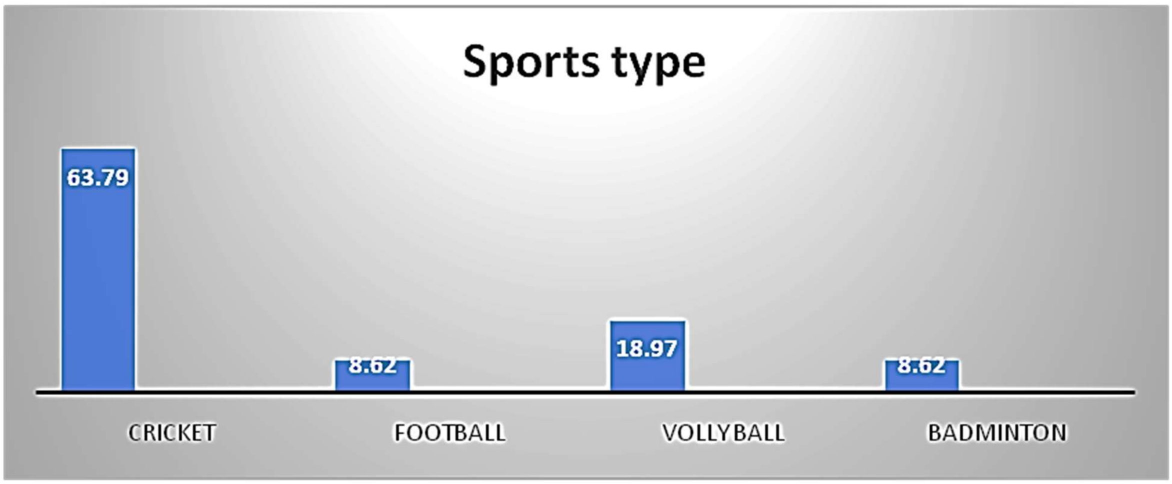

Fig. 1. Athlete involved in various sports

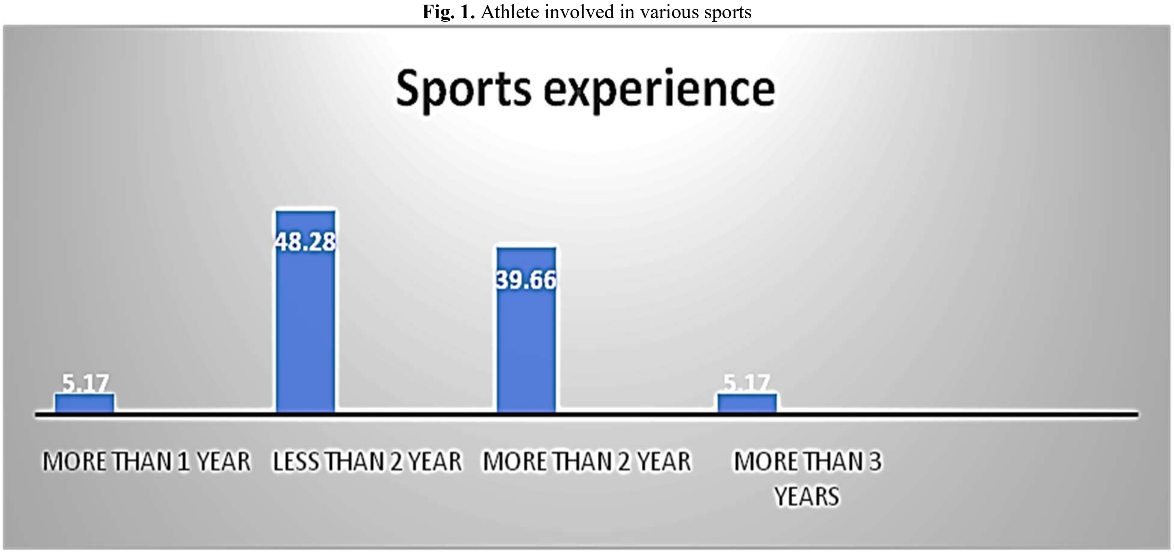

Fig. 2. Duration of sports experience by athletes, in years.