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The Evaluation of the Effect of Balance Training With or Without Shoes on Dynamic Balance and Fatigue Level in Young Athletes With Ankle Sprain – A Randomised Controlled Trial

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ABSTRACT

Background: Ankle sprains are common injuries among athletes and are often associated with recurrent episodes and chronic ankle instability. Impaired dynamic balance and increased fatigue are frequently observed in individuals with ankle injuries. However, the impact of performing balance training with or without shoes on fatigue levels and dynamic balance has not been thoroughly investigated. This study aimed to evaluate the effects of balance training with and without shoes on fatigue levels and dynamic balance in young athletes with ankle sprain.

Methods: A total of 88 participants were recruited using convenience sampling. Four participants discontinued the study, leaving data from 84 subjects for final analysis. Participants were randomly divided into two groups using the odd and even number method. Both groups underwent a 4-week balance training intervention—one group trained with shoes, and the other without. Post-intervention, dynamic balance and fatigue levels were assessed using the Y Balance Test and Fatigue Severity Scale.

Results: Participants in the without-shoes group reported increased fatigue during the initial first two weeks of training ($n = 27, 34$), which was not observed in the group training with shoes. However, both groups showed significant improvement in dynamic balance at the end of four weeks of intervention ($p < 0.05$).

Conclusion: Balance training, whether performed with or without shoes, is effective in improving dynamic balance in young athletes with ankle sprain. However, training without shoes may initially increase fatigue and potentially elevate the risk of injury.

Keywords: ankle sprain, dynamic balance, fatigue, athletes, shoe training

1. INTRODUCTION

Ankle sprain is recognised as the most common lower limb injury among physically active individuals, affecting both recreational and professional athletes (Halabchi & Hassabi, 2020). These injuries frequently occur due to improper landing mechanics, particularly on uneven or unstable surfaces, which place excessive stress on the ankle joint (Prasad & Vishwanath, 2023). It has been reported that around 40% of all traumatic ankle injuries take place during sports participation, and approximately 16% of these sprains are recurrent in nature, posing a continuous risk for athletes and impacting their performance and rehabilitation (Doherty et al., 2014).

The ankle joint's stability is maintained by several ligaments, among which the lateral ligament complex is especially susceptible to repeated injury. This repetitive trauma can compromise joint stability, leading to a condition known as chronic ankle instability (CAI) (Roos et al., 2017; Herzog et al., 2019). Individuals with CAI commonly experience persistent pain, a sense of joint weakness, and frequent re-injury episodes, all of which further disrupt functional movement patterns (Anandacoomarasamy & Barnsley, 2005).

Balance, also referred to as postural control, plays a crucial role in performing activities of daily living (ADLs) and athletic manoeuvres. It refers to the body's ability to maintain its centre of gravity over its base of support, ensuring stability and efficient movement (Lelard & Ahmaidi, 2015; Yogeshwar & Sahoo, 2024). Meta-analyses and clinical studies have consistently reported that ankle injuries negatively affect postural control, proprioception, and neuromuscular function (Bączkowicz et al., 2017). Furthermore, initial lateral ankle sprains often result in compromised static and dynamic balance, which can continue long after an athlete has resumed training or competition, contributing to long-term performance deficits and predisposing them to further injuries due to chronic ankle instability (Jenkins & Cauthon, 2011; Alghadir et al., 2020; Zhang et al., 2020).

In recent years, research has highlighted the role of footwear in influencing an athlete's performance, particularly in relation to balance and ankle joint stability (Wagemans et al., 2021). The human musculoskeletal system is anatomically designed to function without shoes, allowing for greater activation of intrinsic foot muscles and improved sensory feedback through direct contact with the ground (Venkatesh & Shanmugananth, 2023). Based on this understanding, barefoot training has been promoted for its potential to strengthen the musculoskeletal system, improve proprioception, and enhance overall performance. It also offers a cost-effective training method, which historically has been a part of traditional training practices in various athletic disciplines (de Villiers & Venter, 2014; Sánchez-Ramírez & Alegre, 2020).

However, barefoot training may also increase the risk of injury due to the lack of shock absorption, leading to higher loading rates during dynamic activities (Buist et al., 2010). In contrast, modern running shoes are engineered with protective features that cushion impact forces and reduce injury risk (Buist et al., 2010; Tam et al., 2014). Despite their benefits, footwear characteristics such as size, sole thickness, and heel height can directly influence an athlete's balance, proprioceptive input, and motor control during movement (Buist et al., 2010; Tam et al., 2016; Kim et al., 2017).

Beyond balance, fatigue is another key factor affecting athletic performance and injury risk. Fatigue—whether induced by prolonged training or repeated high-intensity activity—has been shown to reduce muscular power output, coordination, and overall physical performance (Burgess & Lambert, 2010). Muscle fatigue not only diminishes functional capacity but also increases susceptibility to injuries during athletic tasks (Sanno et al., 2021; Aquino et al., 2022). Despite this, there is currently limited evidence examining how footwear status, i.e. training with or without shoes, might influence both dynamic balance and fatigue levels in athletes, particularly those with a history of ankle sprain.

Ankle sprains are a major contributor to ankle instability, and this instability is closely associated with deficits in both static and dynamic balance. Although previous literature has extensively discussed the biomechanical and neuromuscular effects of ankle injuries and the role of footwear in performance, no studies to date have directly examined how balance training performed with and without footwear influences dynamic balance and fatigue in athletes with a history of ankle sprains. Given the ongoing functional limitations and risk of re-injury in this population, the current study was conducted to address this gap in the literature and explore the potential impact of barefoot versus shod balance training on performance and fatigue.

Aim & hypothesis

Aim: To evaluate the effect of balance training performed with and without shoes on dynamic balance and fatigue levels in young athletes with a history of ankle sprain.

Hypothesis:

- **Null hypothesis (H_0):**

There is no significant difference in dynamic balance and fatigue levels between young athletes with ankle sprain who undergo balance training with shoes and those who train without shoes.

- **Alternative hypothesis (H_1):**

There is a significant difference in dynamic balance and fatigue levels between young athletes with ankle sprain who undergo balance training with shoes and those who train without shoes.

2. METHODS

Research design

A randomised controlled trial was conducted in the Department of Physiotherapy. All the participants of the study were voluntary. A written consent was taken from all the participants before participation in the study.

Participant recruitment

Both male and female athletes aged between 18 and 30 years were eligible to participate in the study. Participants included were those who had sustained a Grade 1 or Grade 2 unilateral ankle sprain within the past three weeks and had a Cumberland Ankle Instability Tool (CAIT) score of **25 or below**, indicating ankle instability. Subjects were excluded if they had a Grade 3 ankle sprain, an ankle sprain older than six weeks, a CAIT score of **25 or above**, or a history of bilateral ankle sprains. Additionally, individuals with any associated cardiovascular, respiratory, or neurological disorders were not considered for the study.

Sampling method and sample size calculation

Convenience sampling was used to recruit the participants in the study. Sample size was calculated with G*Power software (version 3.1) with 95% of confidence interval, 5% of confidence limit, and 0.8% of effect size and sample size was 84. Four participants were added when the study's dropout rate was calculated as 10%. Thus, the final sample size was 88. The participants were divided into two groups with 44 participants in each group.

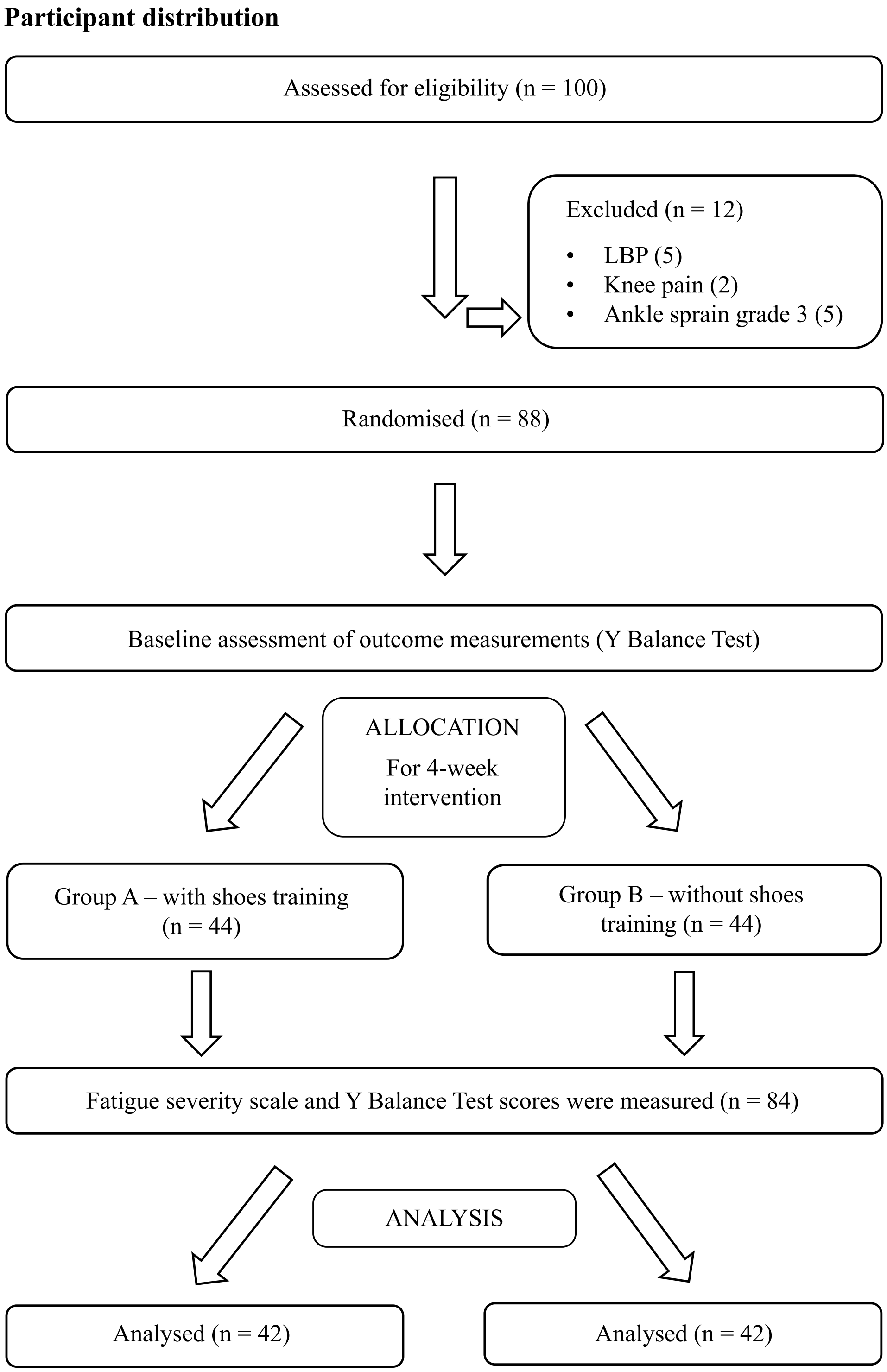
Randomisation

Participants were divided into two groups by odd and even number method. Both the groups were blinded to the study protocol. The intervention was given to all the participants after the baseline assessment of participants. One group received the intervention with shoes and another group received the intervention without shoes. Same intervention was given to both groups and pre- and post- assessment was done for all participants after four weeks of intervention.

Procedure of data collection

A total of 88 participants were recruited for the study based on the predefined inclusion and exclusion criteria. Prior to participation, all individuals were thoroughly informed about the study protocol and the nature of the intervention. Participants were randomly assigned to two equal groups and remained blinded to the allocation of the other group. Additionally, the data analysts involved in the study were blinded to participant group assignments to minimise bias. The intervention was administered on alternate days each week (four sessions per week) for a total duration of four weeks. Each training session lasted 30 minutes. One group performed the balance training with shoes, while the other performed the same balance training without shoes. Both groups received identical training protocols, supervised closely by a qualified therapist to ensure consistency and safety. At the end of the 4-week intervention period, dynamic balance was assessed in both groups using the Y Balance Test. Fatigue levels were evaluated at the end of each week using the Fatigue Severity Scale (FSS) for both groups. The intervention had to be delivered in a pain-free situation; thus, before delivering the intervention, the analysts made sure that the patient is in pain free condition. When required, the pain was managed by a physiotherapist before restarting the intervention. Participants who chose not to continue with the intervention were excluded from the final analysis. During the course of the study, four participants withdrew due to injury and were not included in the data analysis, as illustrated in Figure 1.

Figure 1. **Procedure and allocation**



Intervention. The intervention was implemented over a 4-week period, with sessions conducted on alternate days each week, totalling four sessions per week. Each session lasted for approximately 30 minutes with 10 repetitions of each exercise. The training programme was divided into two progressive phases: Week 1–2 and Week 3–4. The same set of exercises was delivered to both groups—one performing the activities with shoes and the other without shoes—under the close supervision of a therapist to ensure consistency and safety, as shown in Table 1 and Figure 2.

Table 1. **Intervention**

Intervention	Exercise	Repetition	Duration
1–2 week	Tandem standing with eye open	10 rep × 30 s for each	Approx. 30 min
	Tandem walking with eye open	10 rep × 30 s for each repetition	
	Standing with feet together and eye open	10 rep × 30 s for each repetition	
	Heel to toe swaying on balance board with eye open	10 rep × 30 s for each repetition	
	Single leg standing on trampoline	10 rep × 30 s for each repetition	
3–4 week	Single leg squatting on Bosu ball	10 rep × 30 s hold for each	Approx. 30 min
	Single leg standing with Swiss ball catching on Bosu ball	10 rep × 30 s hold for each	
	Balancing & swaying on wooden wobble board	10 rep × 30 s hold for each	
	Tandem standing with eye closed	10 rep × 30 s hold for each	
	Tandem walking with eye closed	10 rep × 30 s hold for each	

Figure 2. **Intervention images**

Outcome measure

1. **Y Balance Test.** The Y Balance Test (YBT) is a reliable tool used to assess dynamic balance in athletes. To perform the test, three strips of tape are arranged on the floor in the shape of a "Y". The angle between the anterior line and each of the posterior lines is set at 135°, with a 45° angle separating the two posterior directions. Prior to the formal assessment, participants are allowed to perform four to six practice trials in each direction to familiarise themselves with the task. During the test, individuals are instructed to reach in three specific directions: anterior, posterolateral, and posteromedial. The composite score is determined by adding the reach distances in all three directions. This test is designed to evaluate the athlete's balance, lower limb strength, and neuromuscular control across multiple movement planes (Prasad & Vishwanath, 2023; Yogeshwar & Sahoo, 2024).
2. **Fatigue Severity Scale.** The Fatigue Severity Scale (FSS) is a method of evaluating the level of fatigue. The FSS questionnaire contains nine statements that rate the severity of your fatigue symptoms in reference of last week. A low value (e.g. 1) indicates strong disagreement with the statement, whereas a high value (e.g. 7) indicates strong agreement. A total score of less than 36 suggests that you may not be suffering from fatigue. A total score of 36 or more suggests that you may need further evaluation by a physician (Dickinson & Hanrahan, 2009; Lelard & Ahmaidi 2015).

Statistical analysis. The data analysis was carried out using IBM SPSS Statistics 20 software. Descriptive statistical analysis was done to evaluate the baseline characteristics of the participants. Paired t test was used to test the significance of with shoes and without shoes training within the group. Unpaired t test was used to test the significance of with shoes and without shoes training between the groups and its effect on dynamic balance.

3. RESULTS

- In total, 84 participants were part of the analysis (59 male and 25 female; 1.30 ± 0.466). The participants were divided into two groups of 42. The participants were between the ages of 18 and 30 (20.79 ± 2.513). Out of 84 participants, 61 had a right sided ankle sprain and 23 had a left sided ankle sprain, as shown in Table 2.

Table 2. **Demographic data**

Components		Frequency	Mean ± SD
Gender	Male	59	1.30 ± 0.466
	Female	25	
Age	18–30 year	84	20.79 ± 2.513
Side	Right	61	1.26 ± 0.442
	Left	23	

- The participants in both groups were trained and assessed separately. One group was assessed with shoes and another without shoes. Results show that subjects who were trained with shoes did not experience much fatigue and the subjects who were trained without shoes were more fatigued during the initial two weeks. However, after the 2-week mark the level of fatigue lessened, as shown in Table 3.

Table 3. **Fatigue level training with and without shoes**

With shoes fatigue							
Week 1		**Week 2**		**Week 3**		**Week 4**	
Fatigue	No fatigue	Fatigue	No fatigue	Fatigue	No fatigue	Fatigue	No fatigue
12	30	10	32	11	31	4	38
Without shoes fatigue							
Week 1		**Week 2**		**Week 3**		**Week 4**	
Fatigue	No fatigue	Fatigue	No fatigue	Fatigue	No fatigue	Fatigue	No fatigue
27	15	34	8	14	28	17	25

- **Independent t test**

Independent t test was used to evaluate the differences in balance between the groups and the findings show that all the participants had impaired balance following ankle sprain. However, after the intervention of four weeks, there was significant improvement seen in both the groups—the participants who were trained with shoes as well as the participants who were trained without shoes—as shown in Tables 4 and 5.

Table 4. **Pre-intervention Y Balance Test (Independent t test)**

Groups	Mean ± SD	t value	p value
Pre-anterior balance without shoes	72.48 ± 12.37	–1.694	0.085
Pre-anterior balance with shoes	72.33 ± 13.20	–0.320	0.947
Pre-right balance with shoes	69.59 ± 13.54	–6.220	0.747
Pre-right balance without shoes	73.00 ± 12.78	–1.015	0.230
Pre-left balance with shoes	71.59 ± 13.48	–1.025	0.478
Pre-left balance with shoes	71.07 ± 13.26	0.351	0.962

Table 5. **Post-intervention Y Balance Test (Independent t test)**

Groups	Mean ± SD	t value	p value
Post-anterior balance without shoes	75.22 ± 13.12	2.243	0.041
Post-anterior balance with shoes	78.67 ± 8.85	0.483	0.011
Post-right balance with shoes	76.04 ± 16.04	0.873	0.050
Post-right balance without shoes	77.89 ± 12.20	0.131	0.025
Post-left balance with shoes	74.82 ± 14.82	0.200	0.047
Post-left balance with shoes	75.00 ± 11.31	1.102	0.033

- **Paired t test**

Paired t test was used to evaluate the differences in balance within the groups and it was found that both groups were able to regain their dynamic balance after the intervention, as shown in Table 6.

Table 6. **Paired t test Y Balance Test**

Groups	Mean ± SD	t value	p value
Pre-post anterior balance with shoes	3.78 ± 15.24	1.609	0.010
Pre-post anterior balance without shoes	3.40 ± 15.80	1.396	0.025
Pre-post right balance with shoes	4.71 ± 19.95	1.531	0.013
Pre-post right balance without shoes	4.57 ± 20.11	1.473	0.014
Pre-post left balance with shoes	4.59 ± 20.26	1.470	0.003
Pre-post left balance without shoes	4.64 ± 19.15	1.571	0.002

4. DISCUSSION

The present study was conducted to investigate the impact of balance training performed **with and without shoes** on **dynamic balance** and **fatigue levels** in athletes with ankle sprain. The results revealed that both training methods—whether performed barefoot or with shoes—contributed positively to the improvement of **dynamic balance**. However, their effects on **fatigue levels** varied significantly between the two groups.

It was observed that athletes who trained **with shoes** experienced **minimal fatigue** throughout the intervention period. In contrast, those who trained **without shoes** reported a **noticeable level of fatigue**, particularly during the **initial two weeks** of training. This fatigue, however, appeared to **decrease in the later stages**, possibly due to the **neuromuscular and musculoskeletal adaptation** to the barefoot training protocol. This adaptive response is consistent with the findings of Sanno et al. (2021) who reported that muscular fatigue tends to diminish over time as the body adjusts to new biomechanical demands.

Despite these adaptations, it was found that participants in the **barefoot training group** were more susceptible to **injuries**, especially in the early phase of the intervention. Reported complications included **pain, redness, and discomfort**, likely caused by increased mechanical load and lack of external support during weight-bearing activities. In contrast, participants who trained **with shoes** did not experience such complications and completed the intervention without injury. The cushioning and structural support provided by footwear may have played a significant role in **shock absorption** and **force distribution**, protecting the foot from excessive stress.

There remains ongoing debate in the literature regarding the relationship between **fatigue and dynamic balance training**. However, the current study presents a clearer picture. A systematic review by Abdelkader et al. (2021) emphasised that fatigue can influence balance performance and should be carefully monitored in training. Notably, most existing studies have not considered the role of **footwear** in this context, making the present study a unique contribution by highlighting how training with shoes can **mitigate early fatigue** and **reduce injury risk**.

Barefoot training tends to increase the **mechanical load** on the lower extremities, particularly in the **early phases** of the training programme. As discussed by Miller et al. (2014), footwear serves as a protective barrier, functioning as a **cushion and shock absorber**, which can prevent injury by reducing peak ground reaction forces during movement.

Although some literature suggests that **barefoot performance** may enhance agility, proprioception, and ankle stability over time (de Villiers & Venter, 2014), it is also evident that **immediate exposure** to barefoot conditions, without gradual progression, can **increase the risk of injury**, particularly when athletes are performing high-speed or high-agility movements. The current study's findings support this concern, showing that participants in the **barefoot group** experienced more **discomfort and dropout** due to injury compared to those in the **shod group**, who completed the full protocol without adverse events.

Moreover, previous studies have indicated that **footwear characteristics**, such as sole thickness, arch design, and fit, can significantly affect performance and injury risk. While barefoot training may improve certain neuromuscular functions, **well-designed athletic shoes** offer **protection, stability, and consistency**, which are crucial, especially in injury-prone populations (Waddington & Adams, 2003; Jenkins & Cauthon, 2011; Altman & Davis, 2016). Although the intervention was generally well-tolerated, some participants experienced pain during the training sessions, which negatively impacted their ability to continue. This discomfort led to the discontinuation of the intervention for those individuals and ultimately interrupted their treatment progress and potential rehabilitation outcomes. During that time, required time was given to participants to recover from pain.

The present study thus highlights a **trade-off** between potential long-term benefits of barefoot training (such as improved proprioception and ankle control) and the **short-term risks**, including increased fatigue and injury. Therefore, based on these findings, it is advisable to initiate balance training **with shoes**, particularly in the early stages of rehabilitation or conditioning. This approach provides a **safer and more stable environment**, reduces fatigue and injury risk, and allows athletes to gradually build strength and stability before progressing to more challenging conditions like barefoot exercises.

5. CONCLUSIONS

In summary, the study concludes that while both barefoot and shod balance training improve dynamic balance, **training with shoes is safer** and associated with **lower fatigue and injury risk** in the early phase of intervention. Barefoot training may offer benefits in **later stages**, but due to its initial strain on the musculoskeletal system, it should be introduced progressively and with caution. Therefore, the present study recommends incorporating **shoes during balance training** for athletes recovering from ankle sprain to ensure **safe progression** and **effective performance outcomes**.

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Informed Consent Statement: A prior written consent was taken from all the participants who were willing to participate in the study and after that recruitment was done for the study.

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Conflicts of Interest: The authors declare no conflict of interest.

Ethical Statement: The ethical statement was obtained from the Departmental Ethics Committee with a reference number NIMS/PTOT/Aug/2024/133.

Data Availability Statement: The data presented in this study are available on request from Dharmita Yogeshwar.

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