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EFFICACY OF BALANCE TRAINING PROGRAM IN REDUCING ANKLE INSTABILITY AMONG RUNNERS

Physiotherapy

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ABSTRACT

Introduction: Ankle sprains are prevalent injuries within physically active individuals. Even a single ankle injury can lead to balance impairments, recurring instability, and subsequent sprains. Recurrent ankle sprain leads to ankle instability. The objective of the present study was to evaluate the alterations of balance parameters among runners with ankle instability and to determine efficacy of balance training program in reducing ankle instability among runners. **Methods:** The study was experimental in nature in which 30 runners, both males (mean age 23.6±2.14) and females (mean age 21.5±1.305) from Punjabi University Patiala were selected as per inclusion criteria with ankle instability and divided into two equal groups, an intervention group and a control group with and without balance training respectively. Pre and post assessments were conducted for both groups using the Cumberland Ankle Instability Tool (CAIT) and balancing parameters, such as A/P and M/L oscillation range and average speed, on a force platform (BTS bio-engineering) followed by data analysis done by using software SPSS-20. **Results:** The intervention group showed statistically significant reduction in A/P and M/L oscillation range and average speed ($P<0.05$) and statistically significant increase in CAIT scores ($P<0.05$) as compared to control group. **Conclusion:** The intervention group showed statistically significant improvement in the CAIT and balance parameters after the balancing exercises. The runners who were part of the intervention group exhibited significantly reduced ankle instability compared to the control group when they performed balancing exercises.

KEYWORDS

Ankle Instability, Balancing Exercises, Centre Of Pressure Displacement, Runners

1. INTRODUCTION

Running is one of the most popular recreation sports, and it may have many positive effects on cardiovascular, musculoskeletal[1], and psychological health [2].Unfortunately, each year, up to 50% of runners experience running-related injuries (RRI) each year[3]. Due to overuse syndromes, poor training methods, or a mix of the two, numerous chronic ailments related to running arise[4]. About 80% of runners (rear foot or heel strikers) establish first ground contact at the postero-lateral edge of the foot as they are running. The midlateral border of the feet of the other runners make initial contact with the ground. (middfoot strikers)[4]. Ankle sprains are among the most common injuries in the physically active population[5].Ankle sprains have been reported to be the most frequent risk factor for ankle injuries[6].A single ankle injury can cause balance problems, recurrent instability, and additional sprains[7]. Recurrent ankle sprain leads to chronic ankle instability (CAI), which can induce an altered muscle activation pattern, recurrent injury, athletic and participation limits, and imbalanced posture[8-9]. In sports, the ankle joint is particularly prone to injury; among the most frequent injuries to the ankle joint is the lateral ankle sprain[10]. Up to 95% of all documented ankle sprains involve injuries to the lateral-ligament complex, making it the most frequently injured structure in the ankle joint[11,12]. CAI can be classified into mechanical and/or functional instability. Mechanical instability is defined as movement beyond of the ankle's normal range of motion[13] and may be brought on by ligament elasticity, anatomical abnormalities, or chronic inflammatory and degenerative processes[14].

Functional ankle instability (FAI) is defined as when the player experiences recurrent sprains and or sense of "giving away"[15]. Balance and coordination training are common components of intervention programs for the prevention and treatment of acute lateral ankle sprains and ankle instability (AI)[16,17]. A wobble board offers an unsteady surface and it might be beneficial as a training tool as it has inbuilt movement sensors to measure the board movement[18]. The COP measures from force-plate data can be analysed to determine the balancing parameters, and they are useful in evaluating the stability and function of the foot[19]. Instrumented wobble boards have also been shown to be effective in reducing ankle instability[20,21]. Balance training programs are effective in improving balance parameters in individuals with ankle instability[22,23]. Overall, the studies reviewed highlight the usefulness of balance training programs as an intervention for individuals with ankle instability. Based on the literature review provided, it appears that various types of balance training programs have been investigated for their effectiveness in reducing ankle instability in individuals. However, there are very few researches specifically investigating the effect of miniboard balance exercises in reducing ankle instability. Overall, there is a need for further research to determine whether mini-board balance exercises are effective in reducing ankle instability. The purpose of the study was to determine the effect of balance training program in reducing the ankle instability among runners.

2. METHODOLOGY

2.1 Participants and Study Design

The study was conducted at Punjabi University, Patiala, Punjab from October 2022 to April 2023. An experimental study in which total 30 runners were selected both males and females with ankle instability on the basis of inclusion criteria, males and females of age 18-28 years, multiple episodes of the ankle giving way or recurrent sprains within the past 6 months, history of at least 1 significant ankle sprain, 100, 200 and 400 meter runner, state, national and international level runners having more than 2 year experience, player not able to perform Romberg's test.

Subjects with bilateral ankle sprain, other lower extremity injuries or surgeries, vestibular disorder, any peripheral neuropathies, and a history of concussion within the last 3 months, non-athletic population, school, college level runners were excluded. Before the commencement of study, Subjects were informed in detail about the aim, purpose, objective and procedure of the study in the language they could easily understand. The study was approved by Institutional Ethical Committee (IEC) of Punjabi University, Patiala via number 37/55/IEC/PUP/2022. A written consent was taken from each subject who was willing to participate.

2.2 Outcome Measures

2.2.1 Static Analysis on Force Platform (BTS Bioengineering)[24]

The Static Analysis test was not invasive for the subject and did not require any specific preparation: it was not necessary for the subject to undress even if it is recommended to perform the test without shoes. The subject must remain in orthostatic position with arms at side, standing still but relaxed in the most comfortable position for 35 seconds. COP displacement was checked.

2.2.2 Cumberland Ankle Instability Tool (CAIT)[25]

Description-The CAIT is a 9-item scale measuring the severity of functional ankle instability. The total score ranges from 0 to 30. Items focus on the degree of difficulty in performing different physical activities per ankle. The CAIT has the ability to discriminate between stable and unstable ankles and measures the severity of ankle instability, with a cut-off value of ≤24 points[25].

2.3 Procedure

In the intervention group, balance training was performed, specifically Mini-board balancing exercises Sensamove BMS 1.0 and SEBT, while the participants in the control group did not undergo any form of balance training program. The participants performed balancing exercises (Mini-board balancing exercises Sensamove BMS1.0 and SEBT) for 4 days a week for four weeks, total 16 sessions.

On the first day of the study, baseline measurements were obtained using the Cumberland Ankle Instability Tool (CAIT) and COP displacement-Anterior/Posterior and Medial/Lateral oscillation range and average speed force platform (BTS Bioengineering) before the administration of the intervention. At the end of the 16th session, the participants were reassessed using the Cumberland Ankle Instability Tool (CAIT) and COP displacement such as Anterior/Posterior and Medial/Lateral oscillation range and average speed force platform (BTS Bioengineering).

2.4 Interventions

2.4.1 Balance exercises on miniboard[26]

On the miniboard, the individual performed these tasks ten times. The first trial was last until the participant loses his or her balance and returns to neutral, after which the second trial began with a pause of 15-20 seconds. In the same way, the procedure was repeated for an additional 3, 4, 5, and so on trials.

Static Stability- For the static stability exercise, the participant stood with one leg on the miniboard while the other leg was free. The goal was to keep the miniboard stabilized while maintaining body position and keeping a red dot (target point) at the centre of a monitor for 6 seconds.

Plantarflexion and Dorsiflexion on Miniboard- One leg was on the miniboard as the participant stood with the other leg free. The participant pushed the miniboard forward and backward while holding each position for six seconds and shifting their ankle to as precisely match the lines displayed on a monitor as feasible. This exercise was also repeated 10 times.

Inversion and Eversion on Miniboard- In this again, the participant stood with one leg on the miniboard while the other leg was free. The participant moved the miniboard front left and right while maintaining body position each for 6 seconds and moving their ankle to follow lines shown on a monitor as accurately as possible. This exercise was also repeated 10 times.

Single Leg Squat on Miniboard- The participant stood with one leg on the miniboard while the other leg was free. The participant performed a single leg squat while maintaining body position for 6 seconds and keeping the red dot (target point) at the centre of a monitor. This exercise was also repeated 10 times.

2.4.2 Star Excursion Balance Test[27]

The SEBT has been shown to be a reliable test to evaluate dynamic balance but can also be used as a clinical rehabilitation exercise. The participant while maintaining their balance on one leg and reaching as far as possible in 8 different directions using the other leg. The directions were anterior, anterior-medial, medial, posteromedial, posterior, posterior-lateral, lateral, and anterolateral. The participant repeated the SEBT 10 times in each direction.

3. RESULTS

When compared to the control group of males (21.6±1.94), the mean age for the intervention group of males (22.5±2.34) was nearly identical and the mean value of age for females of control group was 23.3±1.92 which was higher than the mean value for intervention group females i.e 19.8±0.69 which was statistically non-significant. BMI for the intervention group's male mean and standard deviation was 21.57±3.33 and for control group it was 23.95±1.48 which was nearly close and statistically non- significant. For females the mean and standard deviation of BMI was 20.71±1.98 in intervention group and in control group it was 20.27±2.35 which was remarkably identical and statistically non-significant. The population was homogenous in relation with demographic characteristics namely age, weight, height and BMI. (Table 3.1)

Table 3.1: Demographic Characteristics of the Gender Based Population of Study

	Males			Females		
	Intervention Group	Control Group	t-value	Intervention Group	Control Group	t-value
Parameters	MEAN ± SD	MEAN ± SD		MEAN ± SD	MEAN ± SD	
Age (years)	22.5 ± 2.345	21.6 ± 1.94	.695	19.85 ± 0.690	23.3 ± 1.92	-4.83
Weight (Kgs)	67.16 ± 20.69	71.1 ± 10.60	.406	54.3 ± 4.130	53.58 ± 5.396	.289
Height (cms)	174.1 ± 13.166	172.6 ± 11.45	.211	160 ± 6.324	161.6 ± 4.867	.562
BMI (Kgs/m2)	21.57 ± 3.33	23.95 ± 1.48	1.60	20.71 ± 1.98	20.27 ± 2.35	-.413

*$p \leq 0.05$

The obtained t- value suggest a statistically significant reduction in A/P oscillation range (mm) for the intervention group with balancing exercises program (t=2.94) and non- significant in control group i.e. without balancing exercises program (t=2.16) at *$p \leq 0.05$. Thus, intervention mini-board balancing exercises are effective to reduce ankle instability. (Table 3.2)

Table 3.2: Comparison Pre and Post- Test Scores of A/p Oscillation Range (mm) For Intervention and Control Group.

VARIABLE	PRE-TEST MEAN±SD	POST- TEST MEAN±SD	t-value
INTERVENTION GROUP	26.8667 ± 9.28552	20.9733 ± 6.62457	2.94*
CONTROL GROUP	37.8533 ± 16.71376	28.0133 ± 11.97073	2.16800

*$p \leq 0.05$

Table 3.3 suggest a statistically significant reduction inA/P average speed (mm/s) for the intervention group with balancing exercises program (t=5.69) and non- significant in control group i.e. without balancing exercises program (t=0.76) at *$p \leq 0.05$. Thus, outcome so demonstrates that intervention is successful in improving ankle instability.

Table 3.3: Comparison of Pre and Post-test Scores of A/P Average Speed (mm/s) for Intervention and Control Group

VARIABLE	PRE-TEST MEAN±SD	POST- TEST MEAN±SD	t-value
INTERVENTION GROUP	7.2667 ± 1.29982	6.6267 ± 1.27865	5.69*
CONTROL GROUP	11.1267 ± 14.61078	8.6200 ± 2.35408	0.76100

*$p \leq 0.05$

As per table 3.4, reduction in M/L oscillation range (mm) for the intervention group with balancing exercises program (t=6.27) was statistically significant whereas it was non- significant in control group i.e. without balancing exercises program (t=0.39) at *$p \leq 0.05$. As a result, intervention (mini-board balance exercises and SEBT) was successful in improving the ankle instability among runners.

Table 3.4: Comparison Pre and Post-test Scores of M/L Oscillation Range (mm) For Intervention and Control Group

VARIABLE	PRE-TEST MEAN±SD	POST- TEST MEAN±SD	t-value
INTERVENTION GROUP	13.0467 ± 3.63767	10.4133 ± 3.39787	6.27*
CONTROL GROUP	17.3200 ± 9.82011	16.1733 ± 9.22856	0.39000

*$p \leq 0.05$

A statistically significant reduction was observed in M/L average speed (mm/s) for the intervention group with balancing exercises program (t=4.69) and non- significant in control group i.e. without balancing exercises program (t=0.441) at *$p \leq 0.05$. Thus, intervention mini-board balancing exercises were effective to reduce ankle instability (Table 3.5).

Table 3.5: Comparison of Pre and Post-test Scores of M/L Average Speed (mm/s) for Intervention and Control Group

VARIABLE	PRE-TEST MEAN±SD	POST- TEST MEAN±SD	t-value
INTERVENTION GROUP	11.4333 ± .34365	11.0733 ± .26040	4.69*
CONTROL GROUP	11.4467 ± .33138	11.3800 ± .44913	.44100

*p≤0.05

Table 3.6 suggests a statistically significant increase in CAIT scores for the intervention group with balancing exercises program (t=-30.25) and considerably significant in control group i.e. without balancing exercises program (t=-5.35) at *p≤0.05. Thus, the intervention is effective in enhancing CAIT scores and reducing their ankle instability.

Table 3.6: Comparison of Pre and Post-test Scores of CAIT (Cumberland Ankle Instability Tool) for Intervention and Control Group

VARIABLE	PRE-TEST MEAN±SD	POST- TEST MEAN±SD	t-value
INTERVENTION GROUP	19.7333 ± 1.27988	27.8000 ± .67612	-30.2*
CONTROL GROUP	21.4667 ± 1.59762	22.9333 ± 148645.0	-5.35800

*p≤0.05

4. DISCUSSION

The purpose of this study was to determine the effect of balancing exercises on reducing ankle instability among runners. The findings of present study revealed that the intervention group had significantly improved CAIT scores (p≤0.05) and a decrease in the A/P (Anterior-Posterior) and M/L (Medial-Lateral) oscillation range and average speed on the force platform (p≤0.05) while the control group showed no significant improvement . The result showed that the mini-board balancing exercises and Star Excursion Balance Test were successful in reducing ankle instability among the runners.

Balance training has been shown to improve proprioception and neuromuscular control, leading to a reduction in ankle instability[28]. Several studies offer plausible explanations for the mechanisms that may aid in reducing ankle instability following balancing exercises. Balance training effectively enhanced ankle proprioception, balance, and muscle strength in individuals with chronic ankle instability. This suggests that balance training can improve the ability to sense joint position, critical for maintaining postural control and stability[29]. that balance training can effectively enhance the activity of mechano-receptors in the ankle by stimulating the joint capsule and ligaments[30]. This increases sensory output can activate gamma motor neurons and promote balance, which may help in reducing the ankle instability. Balance-training programs have been successful in improving balance parameters in individuals with ankle instability[31]. Taken together, these findings suggest that balance training can effectively enhance ankle proprioception, balance, and muscle strength and promote the activity of mechanoreceptors to reduce ankle instability. Incorporating balance training into rehabilitation programs may be an effective strategy for individuals with ankle instability.

The findings of the present study were consistent with previous research conducted by various authors[32-34,20-22]. The six weeks of balance training in players with chronic ankle instability showed significant improvements in the ankle instability in experimental group in terms of increase in sensory-motor input and output, centre of mass control, the activation of gamma motor neurons, muscle activation and co-contraction, and CAIT scores [32]. Similarly, in an another study, the six-week balance training using a wobble board improved dynamic balance deficits in individuals with chronic ankle instability[33].

Another study on the effectiveness of wobble board training to reduce symptoms and prevent re-injury in athletes with chronic ankle instability also found that all the patients experienced a comparable degree of pain reduction, increase in strength and no additional ankle injuries as a result of the intervention[20].

Specificity and neural adaptations after balance learning were seen in young adults in a research in which participants were randomly assigned to a balance-specific training (Miniboard, Sensamove), cycle training, or passive control group. The study found that balance-specific training, which involved standing on a wobble board, improved balance performance in the trained task[21]. Another study investigated balance measures to distinguish between functionally unstable and stable ankle. It was seen that the greater values of force plate measures were indicative of impaired balance and the ankle instability group had greater values than the stable ankle group[22].

However, the findings of one study were not in agreement with the aforementioned studies. The study involved 22 subjects randomly assigned to either an intervention group (n=11) or a control group (n=11) to investigate the effects of a balancing training regimen on centre of pressure excursion in one-leg stance. The intervention group received a 5.5 balance training program. However, the results of the study indicated no variations in COP excursions following the balance exercises[34].

The present study utilized COP force plate measures to detect static balance impairments associated with ankle instability. Results showed that subjects with ankle instability exhibited excessive and rapid swaying compared to those with stable ankles, indicating group differences in COP measures. Overall, the results of this study have significant implications for the management of ankle instability among runners and highlight the potential benefits of incorporating balancing exercises into their training programs.

5. CONCLUSIONS

1. The intervention group showed statistically significant improvement in the CAIT and balance parameters such as Centre of pressure- A/P and M/L oscillation range, as well as average speed after the balancing exercises.
2. The runners who were part of the intervention group exhibited significantly reduced ankle instability compared to the control group when they performed miniboard balancing exercises and SEBT.
3. Inclusion of balance training program into the training regimen of runners can be beneficial in reducing ankle instability and therefore, reducing the risk of ankle injury.

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