



EFFECT OF BALANCE TRAINING AND PLYOMETRIC TRAINING ON BALANCE AND POSTURAL CONTROL IN FEMALE BADMINTON ATHLETES WITH FUNCTIONAL ANKLE INSTABILITY

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INTRODUCTION

Ankle injuries are the common among athletes. Ankle sprain is the most common musculoskeletal injuries and accounts for approximately 20% of sports injuries, with severe physical and economics consequences. for example, after ankle sprain, 32- 47% of patient report functional ankle instability (1). The changes in neuromuscular control could affect postural stability in patients with chronic ankle stability (2). It is well established that dynamic stability of the ankle joint is usually controlled by the feed forward mechanism, which uses the visual, auditory, and tactile sense, as previous experience and internal models, to maintain body position and movement (3,4,5). Efficient postural balance not only reduces the risk of the body imbalance, fall, or subsequent injuries, but also contributes to the optimization of motor performance in a number of athletic disciplines (6,7,8). Balance is the important factor in many

athletic skills, but the relationship between sports competition results and the balance is not yet fully understood (9,10). Balance exercise is one of the significant interventions to reduce ankle injuries and rehabilitation (11,12).

This exercise can improve proprioception and the function of the joint mechanical receptors and improve performance and sense of stability in individuals with FAI (13). Balance training has become popular in past few years as a supplementary workout for competitive athletes. For years balance training has been implemented in injuries prevention programs and in many facets of the rehabilitation process (14). Balance training is a progressive type of exercise performed on an unstable surface, and the resultant efferent output causes changes in motor neuron excitability (15). Balance training was used to improve muscle excitability in the ankle joint and increase motor control of CAI (16). Plyometric exercise has shown to be effective in improving lower limb joint stability and coactivation of the hamstrings and the quadriceps in female players (17,18). Plyometric exercise can improve the ability to endure prolonged and high-intensity exertion in both males and females (19). The kinetic characteristics of the landing phase in plyometric exercise can be quantified to establish exercise intensity and its progression in a training program. Landing characteristics in plyometric exercise can be quantified to measure dynamic postural instability. The performance of plyometric exercise should progress from a shortest stabilization time at the beginning of the program, increasing the intensity with a similar increase in stabilization time (20).

The relationship between plyometric training and balance training has been attributed to the promotion of anticipatory postural adjustments, particularly in peripheral joints. Repeated exposure to balance and the stability challenges results in appropriate feed-forward adjustments prior to landing (21). The difference between balance exercise alone and balance exercise plus KT., we hypothesized that the combined balance exercise and KT are effective in improving balance and postural stability and decreasing the severity of ankle instability (22). The effect of 6-week balance exercise on WB in balance, postural stability, and severity of ankle instability of female athletes with FAI (23). Plyometric training is primarily used by strength and conditioning coaches to enhance human neuromuscular function and improve the performances of both explosive- and endurance- based athletes. It is commonly agreed that plyometric training develops the neural and musculotendinous systems of the SSC to generate maximal force in the shortest amount of time. Given this, plyometrics are often used as a method of



the training bridge between strength and speed (24). Players thus need a combination of strength, power and change of direction ability in their lower limbs to win a running or jumping duel, and grasp the ball before the opponent. Nonetheless, due to the rigour of the rule, because of limited playing space, and the exigencies of the game, players are also frequently exposed to situations that upset their balance; they must control their body position and maintain balance when jumping, pivoting, shuffling, changing direction, and withstanding contact from an opponent (25), the capacity to perform quick and powerful movements is one of the most important abilities to acquire to improve performance (26,27,28).). The aim of the study was to verify the effect of the balance training combined with plyometric training on balance postural control in female athletes with functional ankle instability between 18 and 25 years of ages.

BACKGROUND OF THE STUDY

1. SARA MAHMOUDZADEH KHALILI et al (2022) “EFFECT OF COMBINED BALANCE EXERCISE AND KINESIO TAPING ON BALANCE, POSTURAL STABILITY, AND SEVERITY OF ANKLE INSTABILITY IN FEMALE ALTHELETS WITH FUNCTIONAL ANKLE INSTABILITY” stated that the result of this study identified that balance exercise on WB combined with KT enhanced balance and postural stability and reduced the severity of ankle instability in female athletes who had FAI

2. WEN-DIEN CHANG et al; (2021) “EFFECT OF WHOLE-BODY VIBRATION AND BALANCE TRAINING ON FEMALE ALTHELETS WITH CHRONIC ANKLE INSTABILITY” stated that the balance training can significantly enhance postural control, proprioception, and neuromuscular function, leading to improved balance and stability in female athletes with chronic ankle instability.

NEED OF THE STUDY

- Female athletes are at a higher risk of ankle sprains due to anatomical, hormonal, and neuromuscular factors. Recurrent ankle sprains can lead to chronic instability, affecting performance and long-term joint health. Understanding the best training approach can help prevent recurrent injuries.
- Balance and postural control are essential for athletic performance, agility, and injury prevention. Deficits in these areas increase the risk of falls, re-injury, and compensatory movement patterns that may affect other joints.
- FAI affects their ability to maintain proper balance and control, increasing the risk of re-injury.

AIM OF THE STUDY

The aim of this study is to compare the effects of balance training and plyometric training on balance and postural control in female athletes.

OBJECTIVES OF THE STUDY

To compare the effectiveness of balance training and plyometric training in improving static and dynamic balance

To determine the impact of balance training and plyometric training on postural control and stability in athletes with FAI.

To identify which training method is more effective in reducing the risk of recurrent ankle instability.

INCLUSION CRITERIA:

- Female athletes aged 18-25 years.
- Diagnosed with functional ankle instability (FAI) based on some of the balance training and plyometric training, engaged in regular sports activities
- No history of lower limb surgery or fracture in the past 6 months.
- Participants must have a history of ankle sprain and currently experience symptoms of functional ankle instability.

EXCLUSION CRITERIA:

- Acute ankle instability sprain within the last 3 months.
- neuromuscular or vestibular disorders affecting balance.
- participation in other balance training or plyometric training program concurrently.
- participants who are currently experiencing an ankle injury will be excluded.

OUTCOME MEASURE:

Female athletes with functional ankle instability include both objective and subjective assessment.

For **balance training** is evaluated using test such as the (**single leg stance test**), which measure the ability to maintain postural stability under different conditions.

For **plyometric training** is evaluated using test such as (**squad jump**), which measure explosive power, jump height, and landing mechanism.

PROCEDURE:

In this comparative study, 30 patients who fulfilled and exclusion criteria were selected for the study. They were evenly divided into two groups.

- Group-A (15 patients) received balance training program- 6 weeks
- Group-B (15 patients) received plyometric training program for upto 6 weeks

The participants are then randomly assigned to either a balance training group, a plyometric training group. The balance training program consists of exercises like, (single leg stand, tandem stand, wobble board exercise, y balance test). **Single leg stand** (eyes open and closed 3 set of 30 seconds per leg). **tandem stand** (work to balance this stance and hold for 30-45 seconds) **Y balance test** (reach with the opposite leg in different directions 3 sets per leg). **wobble board exercise** (squads while balancing on the wobble board 3 sets of 15 reps). The plyometric training program consists of exercise like, (squat jump, single leg cone jump, single leg bound, hurdle jump). **Single leg squat jump** (2-3 sets of 3-5 reps). **butt & hip cone jump** (3-4 sets of 3-4 reps) **single leg bound** (2-3 sets of 3-4 reps). **hurdle jump** (2-3 sets of 4-5 reps) The intervention typically lasts between 6 to 8 weeks, with training sessions conducted 3 sessions per week. Statistical analyses are performed to determine the effectiveness of each training modality, comparing pre- and post-intervention results. This procedure helps to establish the role of balance and plyometric training in female athletes with functional ankle instability.

TREATMENT PROTOCOL:

Balance training program-group A

➤ Single leg stance

- Stand upright with your feet hip-width apart.
- Distribute your weight evenly across both legs.
- Place your hands on your hips or let them rest naturally by your sides.

➤ Tandem stance

- Stand in the stable surface nearby therapist (for support in case you lose balance).
- Place one foot directly in front of the other so that the heel of the front foot touches the toes of the back foot.

➤ Y balance test

- The participant stands on the hips or at their toes at the centre of the Y configuration.
- They keep their hands on their hips or at their sides to avoid using their arms for balance.

➤ Wobble exercise – squat jump

- Place a wobble board on flat non- slippery surface.
- Stand with both feet evenly shaped on the board, about shoulder- width apart.
- Engage your core and maintain a neutral spine.
- Keep your arm in front of you or slightly bent at sides for balance.

plyometric training program -group B

➤ Single leg squat jump

- Use a flat, non slip surface.
- Stand on one leg with the other leg bent at the knee and slightly behind or in front of you.
- Keep your core engaged and back straight.
- Slightly bend the supporting knee, creating a half-squat position.
- Arm can be extended forward or kept at the sides for balance.

➤ Butt& hip cone jump

- Place the cone in a straight-line formation, approximately 2-3 feet apart.
- Stand with feet hip- width apart near the first cone.
- From the squat position jumps vertically over the cone.
- Tuck your knees towards your chest as you jump, bringing your heels as close to your glutes as possible.

➤ Single leg bound

- Stand on one leg with the knee slightly bent.
- Keep your chest up and back straight.
- Engage your core to maintain stability.
- The other leg should be bent slightly behind or in front of you for balance.
- Your arms should be bent at 90 degrees and ready to swing for momentum.

➤ Hurdle jump

- Set up 4-6 hurdles in a row, spaced 2-3 feet apart (adjust distance based on your ability and jump length)
- Choose hurdle heights appropriate your fitness level.
- Stand facing the first hurdle with feet hip-width apart.
- Bend your knees slightly and engage your core.
- Ready to swing for momentum.

DATA ANALYSIS

The collected data were tabulated and analysed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 26.0. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test was adopted to find the statistical difference between the groups.

TABLE 1

COMPARISON OF VISUAL ANALOG SCALE SCORE BETWEEN GROUP – A AND GROUP-B IN PRE TEST AND POST TEST

VAS	GROUP A		GROUP B		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	7.20	0.71	7.27	0.96	0.239	.836*
POST TEST	2.67	0.61	3.60	0.91	3.287	.000**

(* - $P > 0.05$, ** - $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D), t-test and p-value of the Visual Analog Scale Score between (Group A) & (Group B) in pre test and post test.

This table shows that there is no significant difference in pre test values of the Visual Analog

Scale Score between Group A & Group B (*P > 0.05).

This table shows that there is a significant difference in post test values of the Visual Analog

Scale Score between Group A & Group B (**P ≤ 0.001).

Both the group shows significant decrease in the posttest means but (GROUP-A) which has the lesser mean value is more effective than (GROUP-B).

GRAPH 1

COMPARISON OF VISUAL ANALOG SCALE SCORE BETWEEN GROUP-A AND GROUP-B IN PRE TEST AND POST TEST

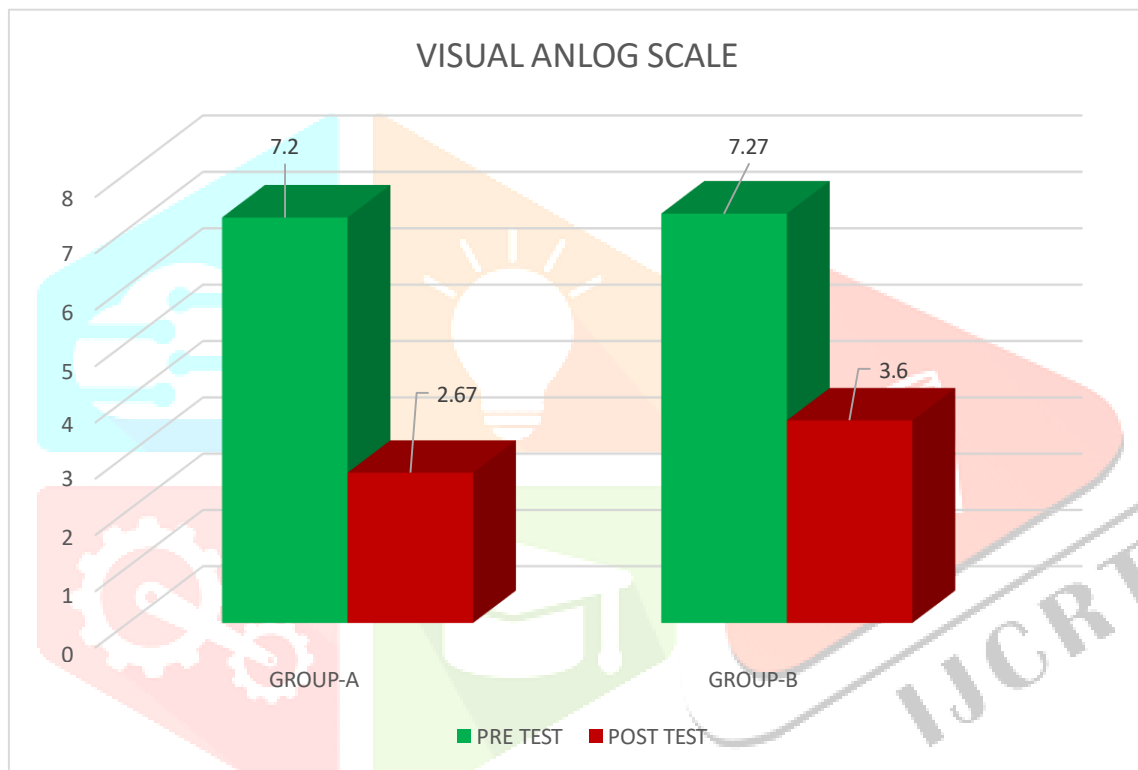


TABLE 2

COMPARISON OF VISUAL ANALOG SCALE SCORE BETWEEN PRE TEST AND POST TEST WITHIN GROUP-A

GROUP-A	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
VAS	7.20	0.71	6.67	0.61	16.562	.000*

(* - $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre-test and post-test within Group – A.

There is a statistically highly significant difference between the pre test and post test values of Visual Analog Scale Score within Group - A (***- $P \leq 0.001$).

GRAPH 2

COMPARISON OF VISUAL ANALOG SCALE SCORE BETWEEN PRE TEST AND POST TEST GROUP-A

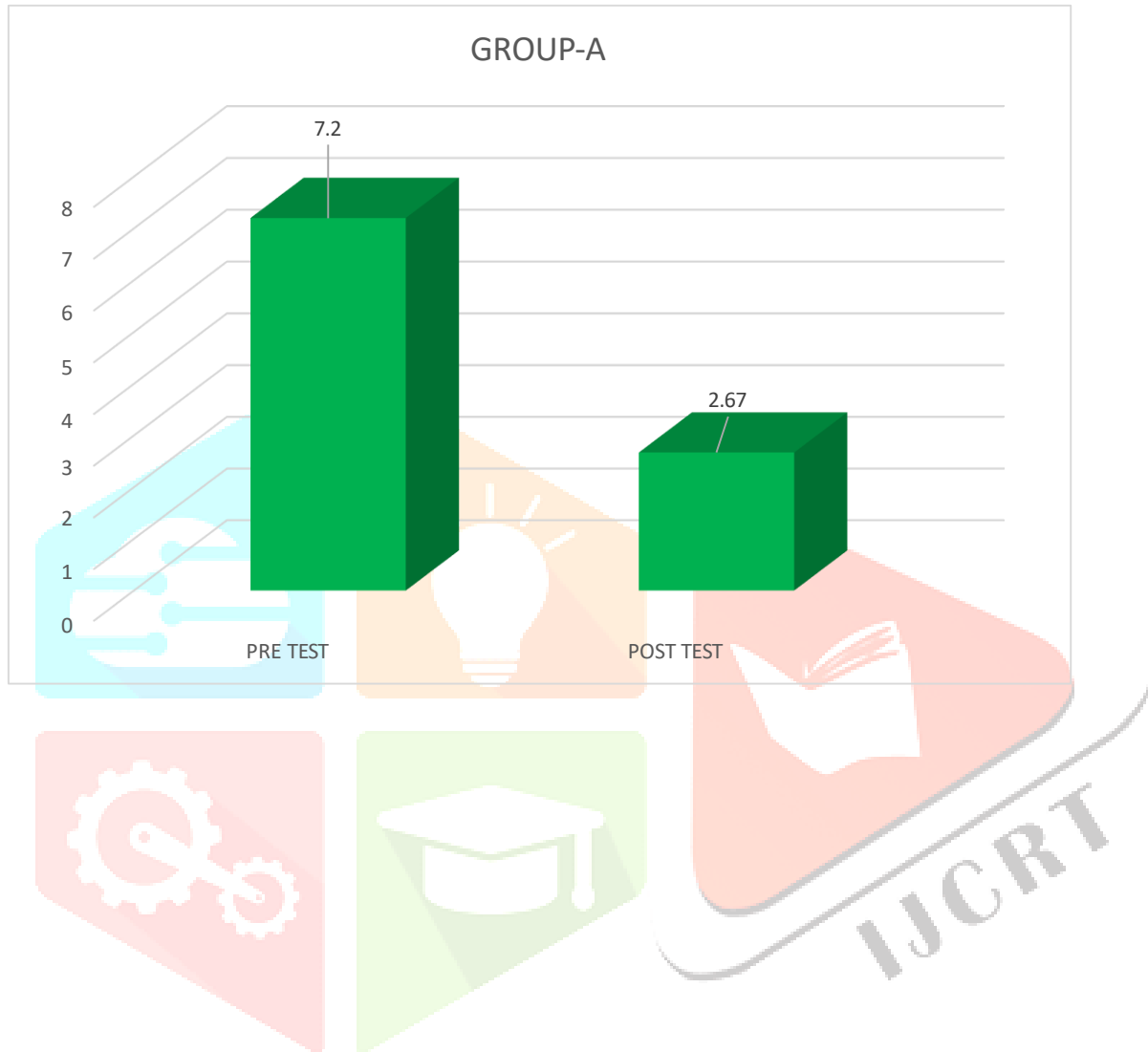


TABLE 3**COMPARISON OF VISUAL ANALOG SCALE SCORE BETWEEN PRE TEST AND POST TEST WITHIN GROUP-B**

GROUP-B	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
VAS	7.27	0.96	3.60	0.91	13.569	.000*

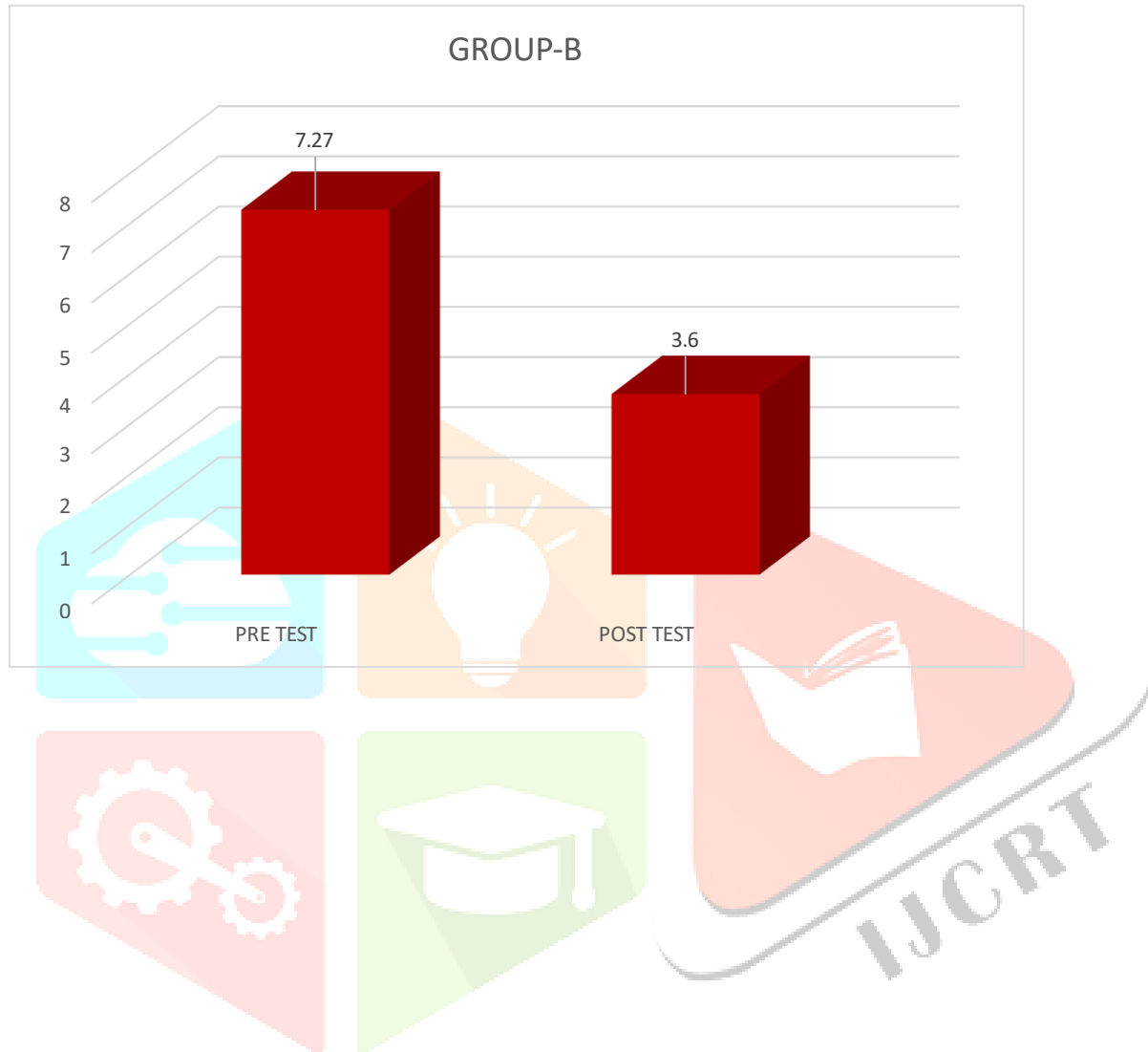
(* - $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre-test and post-test within Group – B.

There is a statistically highly significant difference between the pre test and post test values of Visual Analog Scale Score within Group - B (***) - $P \leq 0.001$).

GRAPH 3

COMPARISION OF VISUAL ANALOG SCALE SCORE BETWEEN PRE TEST AND POST TEST WITHIN GRPOUP-B



RESULT

In Table 1, On comparing mean values of GROUP-A and GROUP-B on Visual Analog Scale Score shows highly significant improvement in the posttest means but GROUP-A shows (2.67) lesser mean value is more

effective than GROUP-B (3.60) at $P \leq 0.001$, Hence the null hypothesis is rejected.

In Table 2 & 3, On comparing Mean Values of Visual Analog Scale Score Between pre test and post test within Group- A and Group - B shows highly significant difference at $p \leq 0.001$. Hence the null hypothesis is rejected.

DISCUSSION

Functional ankle instability (FAI) is a common condition among female athletes, characterized by recurring

ankle sprains, a sensation of "giving way," and compromised balance and postural control. Both balance training and plyometric training have been shown to significantly impact balance and postural stability, though they target different neuromuscular adaptations.

Balance training focuses on proprioception, joint position sense, and neuromuscular coordination. Exercises

such as single-leg stands, wobble board drills, and dynamic balance activities improve sensory feedback and

enhance the athlete's ability to stabilize the ankle joint during movement. This form of training strengthens

stabilizing muscles and reduces the likelihood of reinjury by promoting better postural control and dynamic

balance.

Plyometric training, on the other hand, involves explosive, high-impact movements such as jumps, hops, and

bounds. This type of training enhances muscular power, reaction time, and stretch-shortening cycle efficiency.

In female athletes with FAI, plyometric drills can improve dynamic balance and reactive postural control by

increasing ankle joint stiffness and stability during rapid movements.

Studies comparing the two training methods have shown that while both are effective, balance training is

particularly beneficial for static and dynamic postural control. In contrast, plyometric training is more effective in enhancing functional stability during sports-specific movements. A combined approach may offer the greatest benefit, as it addresses both proprioceptive deficits and reactive control, reducing the risk of ankle re-injury and improving overall athletic performance in female athletes with FAI.

CONCLUSION

The result of this study suggest that balance training is more effective than the plyometric training interventions for improving postural control in female athletes with functional ankle instability (FAI). Balance training focuses on enhancing proprioception, neuromuscular control, and joint stability, leading to improved postural control and a reduced risk of recurrent ankle injuries. Plyometric training, on the other hand, enhances dynamic stability, muscle activation, and reactive strength, which are crucial for maintaining balance during high-impact movements. Studies suggest that a combination of balance training methods may yield the best outcomes, and balance training improves static and dynamic stability, while plyometric exercises enhance explosive movements and neuromuscular coordination. Ultimately, integrating these training approaches into rehabilitation programs can significantly reduce the risk of ankle sprains, improve functional performance, and enhance overall stability in individuals with FAI. However, balance training appears to have a more significant impact on enhancing postural control, particularly in terms of reducing postural sway and improving stability. The combination of balance training and plyometric training may provide an even greater benefit, as it challenges the athlete's proprioception, neuromuscular control, and muscular power. Therefore, incorporating both types of training into rehabilitation programs for female athletes with FAI may be an effective strategy for improving postural control and reducing the risk of future ankle injuries.

LIMITATION & RECOMMENDATION

LIMITATION

- Short follow up.
- Outcomes measures are limited.
- Research is done only among a particular age group for 18 to 25 years
- Duration of the study is only 6 weeks
- The sample size of the study is small.
- Selected age group of 18 to 25 years females only

RECOMMENDATION

Assess the severity of ankle instability in female athletes and develop a rehabilitation program accordingly.

Incorporate balance training exercises into the rehabilitation program, such as single-leg squats, balance boards, and BOSU ball training.

Incorporate plyometric training into the rehabilitation program, such as jump squats, box jumps, and depth jumps.

Always warm up before training or competition and cool down afterwards to prevent injuries.

Perform ankle strengthening exercises, such as calf raises and toe raises, to improve ankle stability

Incorporate balance training into your training program to improve balance and postural control.

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