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Effectiveness Of Plyometrics Versus Bosu Ball Training On Dynamic Balance And Agility Among Athletes

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Abstract:
Background: *Dynamic balance and agility are critical components of athletic performance and injury prevention. Plyometric training and BOSU ball-based training are commonly used interventions to improve neuromuscular control, but comparative evidence between these two approaches remains limited.*
Objective: *To compare the effectiveness of plyometric training and BOSU ball training on dynamic balance and agility among athletes.*
Methods: *This randomized parallel-group experimental study included 34 athletes who were allocated into two groups: a plyometric training group n = 17 and a BOSU ball training group n = 17. Both groups underwent supervised training for 6 weeks. Dynamic balance was assessed using the Y-Balance Test, and agility was assessed using the Agility t test before and after the intervention. Data were analysed using SPSS version 31 with significance set at $p < 0.001$.*
Results: *Within-group analysis demonstrated statistically significant improvements in both dynamic balance and agility following the 6-week intervention in both groups ($p < 0.001$). Between-group analysis revealed that the BOSU ball training group achieved significantly greater improvement in dynamic balance, whereas the plyometric training group demonstrated superior improvement in agility.*
Conclusion: *Although both interventions were effective, BOSU ball–based plyometric training produced greater improvements in dynamic balance and agility than conventional plyometric training performed on a stable surface. The magnitude of improvement was particularly notable in the Y-Balance Test and Agility T-test outcomes, indicating superior neuromuscular and postural control adaptations in the BOSU ball training group.*
Keywords: *Plyometrics, BOSU ball, Dynamic balance, Agility, Athletes*

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I. Introduction:

Agility is typically defined as the ability to quickly change direction or position of the body in response to a stimulus while maintaining control and balance. Whereas, Dynamic balance refers to the ability to maintain stability and control of the body while in motion. It is essential during activities like running, jumping, or sudden directional changes. (WHO) One of the most crucial skills that team sports athletes should regularly work on developing in their strength and conditioning regimens is agility. Agility is generally described as a quick, whole-body movement that changes direction and/or velocity in reaction to a stimulus.[1] It is essential to possess sufficient motor skills in order to compete efficiently. Most of the sports feature various shifts of direction in their framework. Agility is the skill utilised in these types of movements.[2] Plyometrics is a well-known form of 'ballistic training' that aims to increase jump performance. Furthermore, plyometric training has been demonstrated to be an effective way to improve strength, running economy, agility, and sprint performance. Plyometric training has also been shown to help avoid knee injury.[3] Plyometrics has been the subject of much research in recent decades and is a common physical conditioning method for healthy people.[4] Controlling the training level, training surface type, training type, program duration, volume (sets, repetitions, weights), intensity, rest periods between sessions, and repetitions between sets are all necessary for designing an ideal plyometric program. In a supervised situation, plyometric exercise has been shown to be a safe training alternative when appropriately planned.[5] It is often known as the stretch-shortening cycle (SSC) and is characterised by an eccentric contraction of the musculotendinous muscle followed by an instantaneous concentric contraction of the same connective tissues and muscles. In order to improve power in the shortest amount of time, this type of workout involves using muscles with their greatest force. Plyometrics includes a variety of sports actions, including running, jumping, hopping, bounding, throwing, and kicking. Plyometric training has been shown in numerous studies to be a more effective approach than standard resistance training for developing explosive lower limbs and optimising a variety of performance factors, including multiple-directional movement speed.[6] In terms of enhancing athletes' competitiveness, balance ability aids in the reasonable and thorough development of other physical attributes like strength, speed, endurance, agility, coordination, etc., minimising fatigue and enabling athletes to fully utilise their strength during training and competition. Uneven muscular strength distribution and poor body posture can easily cause players to apply too much force to particular areas of their bodies, which can lead to sports injuries. The following equipment is recommended for unstable surfaces and environments: swing boards, Swiss, BOSU, elastic, and suspension devices. As a result, an unstable environment might offer athletes all the stimulus they need in addition to instability demands.[7] Balance ability can help athletes avoid sports injuries by improving their capacity to adjust their body posture during exercise and by giving their joints better support and protection.[8] In recent years, unstable surface training has gained popularity as an additional workout for athletes who compete. It has been used for many years in various aspects of the recovery process as well as in injury prevention programs.[9] Plyometrics and Balance training are both useful for reducing leg dominance and raising neuromuscular power and control metrics in the lower extremities. For female athletes, preseason training may be even more successful when Plyometrics and Balance exercises are combined.[10] The Bosu ball is one of the contemporary aids in the realm of physical training that influences the growth of strength, motor skills, speed, agility, endurance, balance, flexibility, accuracy, and coordination.[11] The reliability and validity of the Agility T-test as a measure of leg power, leg speed, and agility were examined on a total of 304 college-aged men and women selected from varying levels of sport participation. The T-test appears to be highly reliable and measures a combination of components, including leg speed, leg power, and agility, and may be used to differentiate between those of low and high levels of sports participation.[12] The Y-balance test (YBT) is one of the few fields expedient tests that have shown predictive validity for injury risk in an athletic population. It is more time-efficient test that evaluates dynamic limits of stability and asymmetrical balance in only three directions (anterior, posteromedial, and posterolateral). Among multiple raters with limited health care experience, the YBT showed good interrater test–retest reliability and minimal levels of measurement error. [13]

II. Methods:

Participants

For this randomized parallel-group experimental study, 34 athletes with basic demographic profile and aged between 18-30 years were chosen from private sports academy based on inclusion and exclusion criteria. All participants who gave their consent to participate and agreed to follow were included. A blindfold approach of basic randomization was used to select and allocate the participants into two groups Plyometrics group (n=17) and Bosu ball training group (n=17) by sealed envelope method. This was a randomized feasibility selection method. The study was approved by the Institutional Scientific Review Board (ISRB APPROVAL NO: 291/07/2024/ISRB/UGSR/SCPT)

Key Points to Focus on:

- Generating explosive power for the upward jump.
- Prioritize proper landing technique to minimize the risk of injury.
- Aim for a quick turnaround between the landing and the jump.

Safety Considerations:

- Always warm up before starting the exercise and cool down afterwards to prevent injury.
- Prioritize proper technique throughout the exercise to minimize the risk of injury.

Plyometrics:

Participants in this group will receive Plyometric training. The exercise program will span five days per week, over a total duration of six weeks. Rest periods will be included between exercise for optimal recovery. Participants will be instructed about the exercise technique and supervised. It consists of four exercise regimens. Box jumps involve standing in front of the box with feet shoulder width apart. While maintaining a slight bend in the knees, explosively jump up onto the box. Carefully step down the box returning to starting position. Depth jumps involve standing on the box with knees bent, step off landing softly on both feet. Explosively jump up as high as possible as soon as landing. Progression can be done by increasing the height of the box and repetitions for these two exercises. Lateral bounds involve explosively jumping sideways to one side from the starting position. As soon as landing, explosively jump sideways to other side. Continue alternating side and progression is involved by increasing the distance and repetitions. Single-leg hops involve hopping forward on single leg from the starting position. Continue hopping on the same leg for the desired number of repetitions, then switch legs.

Bosu ball training:

Participants in this group will receive Bosu ball training. This exercise program will also span five days per week, over a total period of six weeks under supervision. Rest intervals between exercises is given. Bosu ball training includes Plyometric exercise with Bosu ball. This makes it difficult for the athletes to maintain their balance on improper surface. It consists of four exercise regimens. For all the exercises the starting position is standing on the center of Bosu ball. Added to maintain a slight bend in the knees before and after jumping to absorb the impact. Bosu ball box jumps involve explosively jumping up onto the box from Bosu ball. Then step down from the box returning to starting position. Bosu ball depth jumps involve landing on the surface from Bosu ball then explosively jumping up as high as possible after landing. Bosu ball later bounds include explosively jumping sideways to one side from the Bosu ball. As soon as landing, jump sideways to other side. Continue alternating sides for desired number of repetitions. Bosu ball single-leg hops include standing on the ball with one foot center of the dome. Hop forward on single leg and again on the same leg to desired number of repetitions, then switch legs.

Outcome measure:

1. **Agility T test:** The reliability and validity of the Agility T-test as a measure of leg power, leg speed, and agility were examined on a total of 304 college-aged men and women selected from varying levels of sport participation. The T-test appears to be highly reliable and measures a combination of components, including leg speed, leg power, and agility, and may be used to differentiate between those of low and high levels of sports participation. (Pauole, Kainoa et al., 2000)
2. **Y balance test:** The Y-balance test (YBT) is one of the few fields expedient tests that have shown predictive validity for injury risk in an athletic population. It is more time-efficient test that evaluates dynamic limits of stability and asymmetrical balance in only three directions (anterior, posteromedial, and posterolateral). Among multiple raters with limited health care experience, the YBT showed good interrater test–retest reliability and minimal levels of measurement error. (Scott W. Shaffer et al., 2013)

III. Results:

A total of 34 athletes completed the study (Plyometric group = 17, BOSU ball group = 17). Both groups showed statistically significant improvements in dynamic balance and agility following 4 weeks of training. In the plyometric group, Y-Balance Test scores increased from 80.59 ± 3.90 to 88.53 ± 3.99 ($t = –13.73$, $p < 0.001$) (Table 1), and Agility T-test time significantly decreased from 15.06 ± 1.35 seconds to 10.47 ± 1.29 seconds ($t = 15.41$, $p < 0.001$) (Table 3). Similarly, the BOSU ball group showed a significant increase in Y-Balance Test scores from 82.24 ± 3.31 to 97.35 ± 4.02 ($t = –13.97$, $p < 0.001$) (Table 2) and a significant reduction in Agility T-test time from 16.71 ± 1.36 seconds to 5.53 ± 1.23 seconds ($t = 28.28$, $p < 0.001$)

When post-intervention scores were compared between groups, the BOSU ball training group demonstrated significantly greater improvements than the plyometric group in both outcome measures. For dynamic balance, the BOSU group achieved a higher Y-Balance Test score (97.35 ± 4.02) compared with the plyometric group (88.53 ± 3.99), and this difference was statistically significant ($t = –6.43$, $p < 0.001$) (Table 5). Similarly, agility performance was superior in the BOSU ball group, with a significantly lower Agility T-test time (5.53 ± 1.23 seconds) than the plyometric group (10.47 ± 1.28 seconds) ($t = 11.47$, $p < 0.001$)

Graphical analysis also demonstrated consistent trends across both outcome measures (Graphs 1–3). Although both interventions were effective, BOSU ball–based plyometric training produced greater improvements in dynamic balance and agility than conventional plyometric training performed on a stable surface. The magnitude of improvement was particularly notable in the Y-Balance Test and Agility T-test outcomes, indicating superior neuromuscular and postural control adaptations in the BOSU ball training group.

IV. Discussion:

This study aimed to compare the effectiveness of plyometric training and BOSU ball training on dynamic balance and agility among athletes. Sensorimotor-based training was shown to accelerate neural activation and improve how quickly muscles can produce force. This explains why unstable-surface exercises such as BOSU training may improve balance and movement control by enhancing the nervous system's ability to respond rapidly to postural challenges. [14] Training on unstable surfaces increases muscle activation because the body must recruit more stabilizing muscles to maintain posture. This supports the use of BOSU ball exercises in this study to promote greater neuromuscular engagement compared to traditional stable-surface plyometrics. [15] Programs that combine plyometric and balance-based training produce greater improvements in lower-limb biomechanics than plyometrics alone. This provides theoretical support for BOSU-based plyometric training used in this study. [16] Deficits in postural control are strongly associated with joint instability and injury risk. Improving dynamic balance through unstable-surface training may therefore help reduce injury susceptibility in athletes. [17] Both instability training and conventional resistance training improve strength, but instability-based exercises produce greater improvements in balance and functional performance, justifying the superior Y-balance outcomes observed in the BOSU group.[18] Unstable-surface lower-body training improves movement efficiency and neuromuscular control, indicating that BOSU-based exercises can enhance athletic movement quality rather than only muscular strength.[19] Balance training significantly improves postural control and jump performance in young athletes, supporting the idea that dynamic balance improvements contribute to better overall athletic performance.[20] Plyometric training improves agility by enhancing rapid force production and movement speed, which explains the large reduction in agility T-test time observed in the plyometric group.[21] Balance-oriented training reduces the incidence of lower-limb injuries by improving joint stability. This supports the injury-prevention potential of BOSU-based training seen in improved Y-Balance scores.[22] Balance training enhances neuromuscular control and functional performance, indicating that BOSU-ball training can improve coordination and postural regulation during sport-specific movements.[23] Unilateral balance training improves strength, power, and stability simultaneously, which helps explain why BOSU ball exercises improved both balance and agility in this study.[24] Athletes who undergo balance training demonstrate improved neuromuscular coordination and movement efficiency, contributing to better control during dynamic athletic actions.[25]

Plyometric training enhances neuromuscular efficiency and explosive performance by improving the stretch-shortening cycle, which explains the strong agility improvements in the plyometric group.[26] Jump-based training increases power and force production, supporting the use of plyometric exercises to improve speed and directional change ability. [27] BOSU ball training significantly improves dynamic balance in young athletes, directly supporting the superior Y-Balance outcomes observed in BOSU group.[28]

V. Limitations:

This study has several limitations. The duration of the intervention may have influenced the magnitude of observed improvements. A longer training period could yield more significant adaptations. Additionally, individual differences in baseline agility and balance could have affected the responsiveness to training. No long term follow up.

VI. Recommendations:

Future research should explore the long-term effects of combining plyometric and BOSU ball training, as well as their impact on different athletic populations, including both gender athletes and those recovering from injuries. Further studies should also investigate the underlying neuromuscular mechanisms contributing to the observed improvements.

VII. Conclusion:

This study demonstrates that both Plyometrics and Bosu ball training lead to significant improvements on dynamic balance and agility among athletes. While Bosu ball training showed greater improvements on dynamic balance and agility compared to Plyometrics which was carried out on stable surface. Bosu ball due to its unstable surface nature when combined with regular Plyometrics exercise yield the desired outcomes and showed greater difference in improvement.

Conflict Of Interest:
Authors declare no conflict of interest.

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Declaration:
ISRB approval no: 291/07/2024/ISRB/UGSR/SCPT
Funding: No funding
Competing interests: NIL
Consent to participate: Informed consent was obtained from all participants included in this study.
Sustainable Development Goals (SDG):

This study contributes to the United Nations Sustainable Development Goal 3 (Good Health and Well-Being) by providing evidence-based exercise interventions aimed at improving dynamic balance and agility in athletes. By enhancing neuromuscular control and reducing injury risk, the findings support the promotion of physical fitness, injury prevention, and long-term musculoskeletal health among physically active populations.

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Tables And Graphs:

GROUP A	MEASUREMENT	MEAN	STANDARD DEVIATION	't' VALUE	P VALUE
Plyometrics exercise group	Pre test	80.59	3.906	-13.734	<0.001
	Post test	88.53	3.986		

Table 1: Comparison of pre-test and post-test values of Y Balance test for Plyometrics exercise group

GROUP B	MEASUREMENT	MEAN	STANDARD DEVIATION	't' VALUE	P VALUE
Bosu ball training group	Pre test	82.24	3.308	-13.970	<0.001
	Post test	97.35	4.015		

Table 2: Comparison of pre-test and post-test values of Y Balance test for Bosu ball training group

GROUP A	MEASUREMENT	MEAN	STANDARD DEVIATION	't' VALUE	P VALUE
Plyometrics exercise group	Pre test	15.06	1.345	15.409	<0.001

	Post test	10.47	1.291		

Table 3: Comparison of pre-test and post-test values of Agility T Test test for Plyometrics exercise group

GROUP B	MEASUREMENT	MEAN	STANDARD DEVIATION	't' VALUE	P VALUE
Bosu ball training group	Pre test	16.71	1.359	28.284	<0.001
	Post test	5.53	1.231		

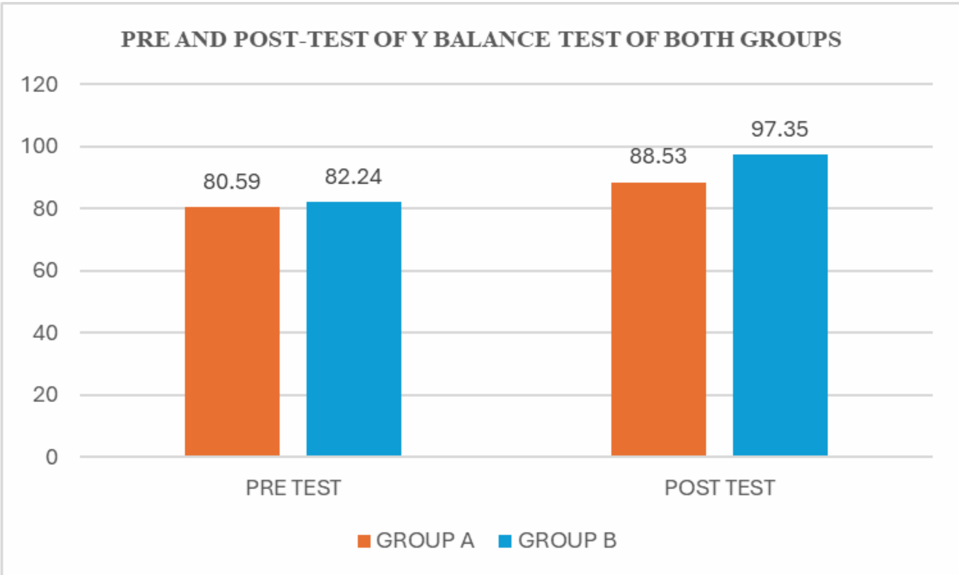
Table 4: Comparison of pre-test and post-test values of Agility T Test test for Bosu ball training group

GROUP	MEASUREMENT	MEAN	STANDARD DEVIATION	UNPAIRED 't' VALUE	P VALUE
Plyometrics exercise group	Post-test	88.53	3.986	-6.430	<0.001
Bosu ball training group		97.35	4.015		

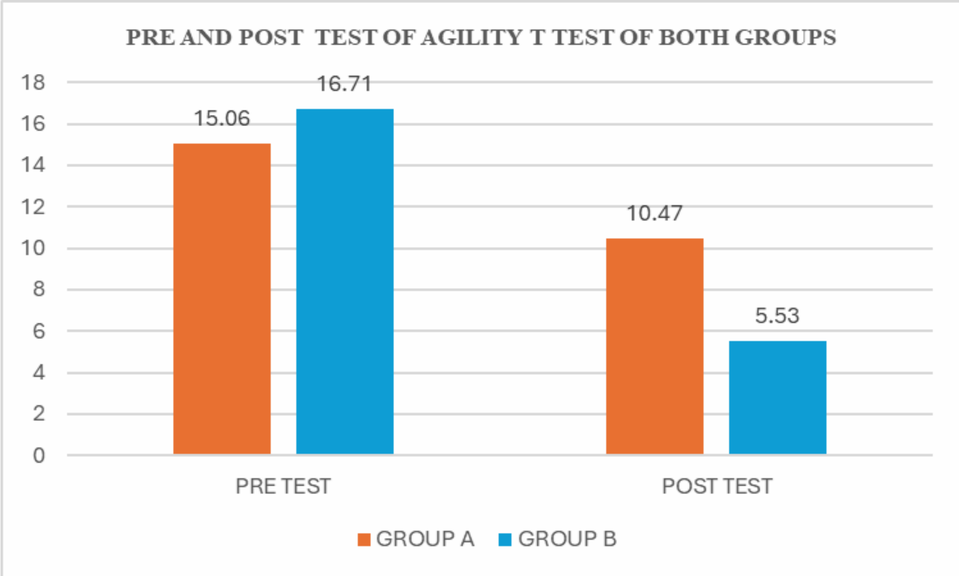
Table 5: Comparison of post-test values of Y Balance test in Plyometrics exercise group & Bosu ball training group

GROUP	MEASUREMENT	MEAN	STANDARD DEVIATION	UNPAIRED 't' VALUE	P VALUE
Plyometrics exercise group	Post-test	10.47	1.281	11.471	<0.001
Bosu ball training group		5.53	1.231		

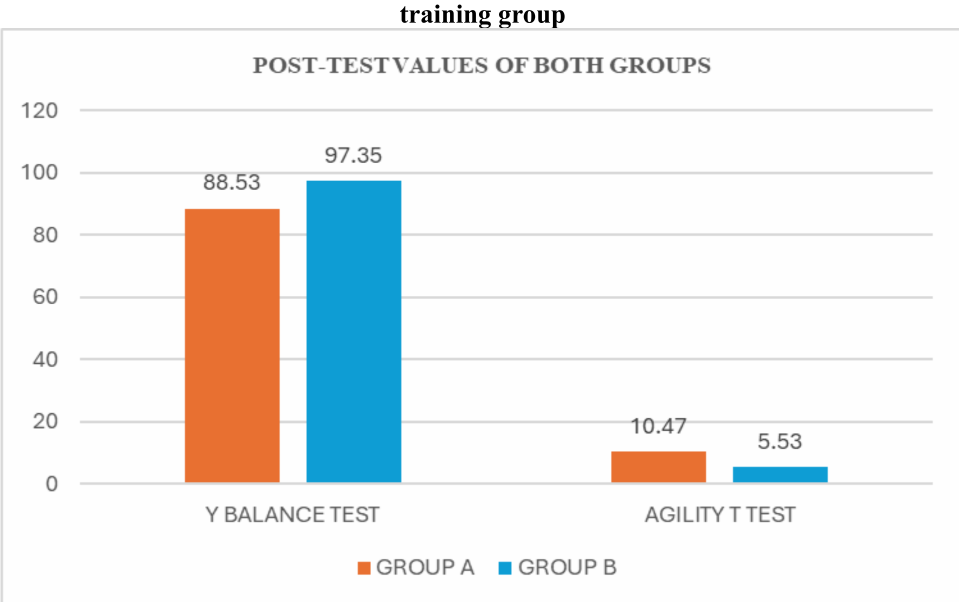
Table 6: Comparison of post-test values of Agility T Test in Plyometrics exercise group & Bosu ball training group



Graph 1: Comparison of pre-test and post-test values of Y Balance test in Plyometrics and Bosu ball training group



Graph 2: Comparison of pre-test and post-test values of Agility T Test in Plyometrics and Bosu ball training group



Graph 3: Comparison of post-test values of Y Balance test and Agility T Test in Plyometrics and Bosu ball training group