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The Impact of BOSU Ball Training on Balance Performance among Elite Volleyball Players: An Experimental Study

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Abstract

The aim of this study was to examine the effects of BOSU ball exercises on balance performance in elite volleyball players. A total of 36 elite athletes (20 male, 16 female) competing in the Turkish Volleyball 1st League voluntarily participated in the study. In addition to their regular volleyball training, the participants performed BOSU ball exercises for six weeks. A pre-test-post-test experimental design was employed, and both static and dynamic balance performances were evaluated using the SportKAT 4000 balance measurement device. The collected data were analyzed using IBM SPSS 26.0 software. The findings revealed statistically significant improvements in all balance parameters for both male and female athletes following the training period ($p<.05$). Particularly, large effect sizes (Cohen's $d>0.8$) were observed in the static right leg and dynamic right leg balance scores. These results indicate that BOSU ball exercises enhance postural control and proprioceptive sensitivity by promoting neuromuscular adaptation within a relatively short period of time. In conclusion, BOSU ball exercises are an effective training method for improving static and dynamic balance, strengthening neuromuscular coordination, and enhancing postural stability in elite volleyball players. Therefore, BOSU-based balance training can be recommended as a complementary component in performance programs for sports such as volleyball, where balance, agility, and strength are key performance determinants.

Keywords: Balance, BOSU ball, neuromuscular adaptation, proprioception, volleyball

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INTRODUCTION

Volleyball is a team sport that requires a high level of agility, reaction speed, balance, and coordination. The ability of players to maintain their performance depends not only on technical skills but also on physical qualities such as postural control, balance, and muscle strength. Balance is defined as the ability to maintain the body's center of gravity over its base of support in a controlled manner, and it is recognized as an essential component of athletic performance (Gabbett, 2016). In particular, balance ability in elite athletes is a direct determinant of both in-game performance and the likelihood of injury (Behm & Chaouachi, 2011).

Balance is defined as the ability to maintain the body's center of gravity over its base of support during both static and dynamic tasks, and it is considered a key determinant of performance continuity and injury prevention in athletes (Behm & Chaouachi, 2011; Eylen et al., 2017). Effective balance control relies on the coordinated functioning of sensory and neuromuscular systems, enabling rapid and accurate postural adjustments in response to external stimuli (Gao, 2025). BOSU ball exercises enhance these mechanisms by increasing proprioceptive input and activating stabilizer muscles, thereby contributing to improvements in postural control (Yee et al., 2023). Such instability-based training provides a performance advantage in volleyball, where quick and precise balance adjustments are required during spiking, blocking, and defensive movements (Wang et al., 2025).

The BOSU ball provides an unstable surface that increases proprioceptive input and activates stabilizer muscles of the body. Athletes performing these exercises in single- and double-leg positions have the opportunity to improve intermuscular coordination while maintaining balance (Tanır, 2018). Unstable surfaces such as the BOSU ball are considered effective tools for enhancing both static and dynamic balance by activating stabilizer muscles (Yaggie & Campbell, 2006).

Elite volleyball players who train at a high level exhibit motor skill that require strong balance control, such as jumping, sudden stopping, and changing direction. Therefore, implementing specific exercise methods aimed at improving balance is of critical importance for enhancing performance and minimizing the risk of injury (Hrysomallis, 2011). Although previous studies have examined the general effects of BOSU or instability-based exercises, there is a lack of research specifically investigating how a structured BOSU training program influences both static and dynamic balance parameters in elite volleyball athletes, who have unique sport-specific balance demands. This gap highlights the need for studies focusing on high-performance populations rather than recreational or youth athletes. Based on this rationale, the present study aims to investigate the effects of BOSU ball exercises on balance parameters in elite volleyball athletes. Accordingly, it was hypothesized that the six-week BOSU training program would lead to significant improvements in both static and dynamic balance performance compared with pre-training values.

METHOD

Research Model

The purpose of this study was to examine the effects of BOSU ball exercises on balance parameters in elite volleyball athletes. An experimental method was chosen for the research design. Experimental designs provide a high level of control in determining cause-and-effect relationships (Büyüköztürk et al., 2021). Therefore, the effects of BOSU ball exercises were directly observed through interventions applied to the participants, and pre-test and post-test differences were statistically analyzed. Such designs are frequently preferred for objectively evaluating changes in performance variables (Hopkins, 2000; Creswell & Creswell, 2017).

Research Group

The study group consisted of 36 elite volleyball players (20 males and 16 females) competing in the Turkish First Volleyball League. A priori power analysis performed using G*Power (Faul et al., 2007) with α=0.05, G*power=0.80, and a medium effect size indicated that a minimum sample size of 28 participants was required; therefore, a sample of 36 athletes was considered sufficient for statistical power. Inclusion criteria were: being an elite volleyball athlete aged 18-30 years, having no musculoskeletal injury in the past year, and participating regularly in team training. Exclusion criteria included any neurological or vestibular disorder, recent orthopedic surgery, chronic medication use affecting balance, or prior BOSU training experience. All athletes continued their regular volleyball training program, which consisted of 4-5 weekly sessions including technical-tactical drills, plyometric work, and match-based training. BOSU exercises were added as supplementary training for six weeks. All measurements were conducted under standardized health and safety protocols in the university sports performance laboratory, with equipment calibration and continuous researcher supervision to minimize injury risk.

Data Collection Tools

Static and dynamic balance performances of the athletes were assessed using a kinesthetic balance measurement device (SportKAT 4000-TS, LLC, Vista, CA, USA) in a controlled indoor laboratory environment with standardized lighting, temperature (22-24°C), and a non-slip testing surface. All devices were calibrated prior to each measurement session. Before testing, athletes completed a standardized 10-minute warm-up and were instructed to avoid strenuous exercise for 24 hours and caffeine consumption for 6 hours. Familiarization trials were provided to ensure accurate test execution. The hydraulic pressure of the balance platform was set to 6 psi, a level commonly used in the literature to provide a moderate stability challenge suitable for trained athletes. Each balance condition (right leg, left leg, and double-leg) was performed three times, and the mean score of the trials was used for analysis.

Static Balance Measurement: During the static balance test, participants were instructed to maintain their body weight on the platform in a fixed position so that the “X” mark displayed on the device screen remained centered. Before the test began, each participant was asked to bring the “X” to the middle of the screen; once stabilized, the 30-second measurement automatically started. At the end of the period, the balance index value produced by the device was recorded for analysis. In this measurement, lower balance index scores indicate better static balance performance, as they reflect reduced postural sway.

Dynamic Balance Measurement: In the dynamic balance test, a circular target moving counterclockwise appeared on the monitor. Participants were asked to maintain their balance for 30 seconds by shifting their center of gravity forward, backward, right, and left to follow the moving target. Athletes received visual feedback by monitoring the real-time displacement of their center of gravity on the screen, allowing them to focus on the target position. At the end of the 30-second period, the balance score generated by the device was recorded and used for analysis. In this test, lower balance scores indicate better dynamic balance performance, as they reflect reduced deviation from the moving target.

Training Program:

Table 1. Six-week BOSU ball exercise program

Week	Exercise	Duration/Repetition	Rest	Description
1-2	Double-leg balance on BOSU	3×30 s	30 s	Static balance position
	Mini squat on BOSU	3×12	30 s	Dynamic balance, lower extremity activation
	Single-leg balance	2×20 s / leg	30 s	Static single-leg stabilization
	BOSU plank	3×30 s	30 s	Static core stabilization
	Russian twist on BOSU	3×15	30 s	Rotational core activation
3-4	Single-leg squat on BOSU	3×10	30 s	Dynamic single-leg balance control
	Lunge on BOSU	3×10 (each leg)	30 s	Dynamic lower extremity stabilization
	BOSU push-up	3×12	30 s	Upper-body stabilization
	Side plank on BOSU (right/left)	2×20 s / side	30 s	Lateral core stabilization
	Medicine ball pass on BOSU	3×10	30 s	Reactive balance and coordination
5-6	Single-leg jump-landing on BOSU	3×8	30 s	Reactive dynamic balance
	BOSU lateral step-over (side-to-side)	3×20 s	30 s	Speed and directional control
	BOSU squat with resistance band shoulder press	3×12	30 s	Combined balance and strength
	BOSU plank shoulder tap	3×20 s	30 s	Dynamic core stabilization
	BOSU reaction balance drill	3×30 s	30 s	Reactive balance and visual control

Data Procedure

This study was designed as a pre-test-post-test experimental model. After recording participants' demographic characteristics (age, height, body weight, and years of athletic experience), all athletes completed the same intervention protocol. For six weeks, in addition to their routine volleyball training, participants performed a BOSU ball exercise program lasting 20-25 minutes, implemented immediately after their technical-tactical training sessions. The selected duration is consistent with the literature, as instability-based balance training studies commonly employ session durations between 15 and 30 minutes to elicit neuromuscular and proprioceptive adaptations without inducing excessive fatigue (Behm & Colado, 2013; Lesinski et al., 2015). Therefore, the 20-25-minute protocol used in this study aligns with established recommendations for effective balance training in athletic populations. Before and after the six-week intervention, athletes underwent assessments of static and dynamic balance performance. Six balance parameters were measured: static right leg, static left leg, static double-leg, dynamic right leg, dynamic left leg, and dynamic double-leg balance.

Data Analysis

The statistical analysis of the data obtained within the scope of the study was performed using the IBM SPSS Statistics 26 software package. During the analysis process, descriptive statistics (arithmetic mean, standard deviation, minimum, and maximum values) were first calculated, followed by an assessment of the distribution characteristics of each variable using the Shapiro-Wilk normality test. The Shapiro-Wilk results indicated that some variables met the normality assumption, while others did not. Accordingly, the Paired Samples t-test was applied to normally distributed variables, whereas the Wilcoxon Signed-Rank Test was used for variables violating the normality assumption. The level of statistical significance was set at a 95% confidence interval ($p<0.05$). In addition, to determine the practical significance of the statistically significant differences, Cohen’s d effect size was calculated. According to Cohen’s (2013) classification, values of 0.2, 0.5, and 0.8 represent small, medium, and large effect sizes, respectively. This approach enabled the results to be evaluated multidimensionally by considering not only statistical significance but also the magnitude of the effect.

FINDINGS

The statistical analyses compared the participants’ pre-test and post-test measurements to determine the effects of BOSU ball exercises on static and dynamic balance performance. Depending on the distribution characteristics of the variables, either the Paired Samples t-Test or the Wilcoxon Signed-Rank Test was used. Effect sizes were additionally calculated to evaluate the magnitude of significant changes. In addition, the magnitude of significant differences was assessed using Cohen’s d effect size coefficient to determine the practical significance of the findings.

Table 2. Demographic and physical characteristics of the participants

Variables	Group	n	Minimum	Maximum	$\bar{X}$	SD
Age (years)	Male	20	20	26	23.15	1.57
	Female	16	19	25	21.88	1.71
	Total	36	19	26	22.58	1.73
Height (cm)	Male	20	175	194	184.55	4.25
	Female	16	162	178	170.44	4.65
	Total	36	162	194	178.28	8.34
Body Weight (kg)	Male	20	71	83	77.20	3.52
	Female	16	50	65	56.62	4.08
	Total	36	50	83	68.06	11.02
Training Experience (years)	Male	20	8	11	9.60	0.94
	Female	16	7	10	8.75	1.00
	Total	36	7	11	9.22	1.05

As shown in Table 2, the elite-level volleyball players who participated in the study demonstrated a homogeneous distribution in terms of age, height, body weight, and training experience. The male athletes had a mean age of 23.15±1.57 years, a mean height of

184.55±4.25 cm, and a mean body weight of 77.20±3.52 kg. For the female athletes, the mean age was 21.88±1.71 years, the mean height was 170.44±4.65 cm, and the mean body weight was 56.62±4.08 kg. The mean training experience was 9.60±0.94 years for male athletes and 8.75±1.00 years for female athletes, indicating that both groups had long-term athletic experience in their discipline. When the overall sample (n=36) was evaluated, the mean age was 22.58±1.73 years, the mean height was 178.28±8.34 cm, the mean body weight was 68.06±11.02 kg, and the mean training experience was 9.22±1.05 years. These findings indicate that the participants represent an elite performance group and that there were no extreme differences in physical characteristics that could influence balance performance outcomes.

Table 3. Pre-test, Post-test, absolute change, and percentage change in balance parameters for male athletes

Variable	n	Pre-Test (M±SD)	Post-Test (M±SD)	Change (Post-Pre)	Change (%)	t	p	Cohen's d
Static Right Leg	20	247.90± 45.26	181.15±32.98	-66.75	-26.9%	10.86	0.000	1.69
Static Left Leg	20	268.95± 61.44	208.45±76.67	-60.50	-22.5%	5.29	0.000	0.87
Static Double-Leg	20	198.15± 41.74	151.00±25.90	-47.15	-23.8%	6.92	0.000	1.36
Dynamic Right Leg	20	466.85± 77.46	359.90±57.17	-106.95	-22.9%	7.97	0.000	1.57
Dynamic Left Leg	20	491.85± 70.15	399.30±89.29	-92.55	-18.8%	5.83	0.000	1.15
Dynamic Double-Leg	20	499.90± 77.87	407.55±67.55	-92.35	-18.5%	6.53	0.000	1.27

Note. p < .05. Cohen's d classification: 0.2 = small, 0.5 = medium, ≥0.8 = large effect size.
% Change = (Post-Test - Pre-Test) / Pre-Test×100.

As shown in Table 3, all balance parameters of the male athletes improved significantly from pre-test to post-test (p<.05). The largest improvements were observed in static right leg balance (-26.9%) and dynamic right leg balance (-22.9%), both of which demonstrated large effect sizes (d=1.69 and d=1.57, respectively). Static double-leg (-23.8%) and static left leg balance (-22.5%) also showed meaningful improvements with large and moderate-to-large effect sizes. Similar significant improvements were found in the dynamic left leg (-18.8%) and dynamic double-leg (-18.5%) parameters. Overall, the percentage changes and effect size values indicate that the six-week training protocol produced substantial improvements in both static and dynamic balance performance among male athletes.

Table 4. Pre-test, post-test, absolute change, and percentage change in balance parameters for female athletes

Variable	n	Pre-Test (M±SD)	Post-Test (M±SD)	Change (Post-Pre)	Change (%)	t/z	p	Cohen's d
Static Right Leg	16	247.90±45.26	181.15±32.98	-66.75	-26.9%	t=10.55	0.000	1.49
Static Left Leg[1]	16	268.95±61.44	208.45±76.67	-60.50	-22.5%	z=7.00	0.001	0.70
Static Double-Leg	16	198.15±41.74	151.00±25.90	-47.15	-23.8%	t=6.05	0.000	1.14
Dynamic Right Leg	16	466.85±77.46	359.90±57.17	-106.95	-22.9%	t=8.84	0.000	1.01
Dynamic Left Leg[1]	16	491.85±70.15	399.30±89.29	-92.55	-18.8%	z=2.50	0.000	1.57
Dynamic Double-Leg[1]	16	499.90±77.87	407.55±67.55	-92.35	-18.5%	z=0.00	0.000	0.80

Note. p<.05. Cohen's d classification:0.2=small, 0.5=medium, ≥0.8=large effect size.
% Change=(Post-Test-Pre-Test) / Pre-Test×100.
[1]Variables analyzed with the Wilcoxon Signed-Rank Test due to violation of normality assumptions.

As shown in Table 4, all balance parameters of the female athletes improved significantly from pre-test to post-test (p<.05). The largest percentage improvements were observed in the static right leg (-26.9%) and dynamic right leg (-22.9%) balance scores, both demonstrating large effect sizes (d=1.49 and d=1.01, respectively). Static double-leg balance also showed a substantial improvement (-23.8%; d=1.14). Moderate-to-large improvements were found in the static left leg (-22.5%; z=7.00; d=0.70), dynamic left leg (-18.8%; z=2.50; d=1.57), and dynamic double-leg (-18.5%; z=0.00; d=0.80) parameters. Overall, the percentage change values and effect size results indicate that the six-week training protocol produced meaningful gains in both static and dynamic balance performance among female athletes.

Table 5. Pre-test and Post-test results of balance parameters for all athletes

Variable	n	Pre-Test (M±SD)	Post-Test (M±SD)	Change (Post-Pre)	Change (%)	t/z	p	Cohen's d
Static Right Leg[1]	36	228.39±46.13	168.44±35.91	-59.94	-25.97%	z=1.00	0.000	-2.38
Static Left Leg[1]	36	231.33±75.31	181.11±69.32	-50.22	-20.33%	z=43.00	0.000	-1.13
Static Double-Leg	36	187.61±40.26	146.19±25.34	-41.42	-20.45%	t=8.98	0.000	-1.50
Dynamic Right Leg	36	424.67±87.59	335.64±64.35	-89.03	-20.17%	t=10.18	0.000	-1.70
Dynamic Left Leg	36	494.44±58.37	404.89±78.74	-89.56	-18.02%	t=8.20	0.000	-1.37
Dynamic Double-Leg[1]	36	493.08±83.30	409.00±78.48	-84.08	-16.68%	z=2.50	0.000	-1.52

Note. p<.05. Cohen's d classification: 0.2=small, 0.5=medium, ≥0.8=large effect size.
% Change=(Post-Test-Pre-Test)/Pre-Test×100.
[1]Since the assumption of normality was not met for this variable, the Wilcoxon Signed-Rank Test was used.

As shown in Table 5, statistically significant improvements (p<.05) were observed across all balance parameters for the entire sample (n=36). The static balance tests demonstrated notable reductions in balance index scores, with the static right leg showing a 25.97% improvement (z=1.00; p<.001; d=-2.38) and the static left leg a 20.33% improvement (z=43.00; p<.001; d=-1.13). The static double-leg balance also improved by 20.45% (t=8.98; p<.001; d=-1.50). Similarly, significant improvements were found in all dynamic balance parameters. The dynamic right leg improved by 20.17% (t=10.18; p<.001; d=-1.70), while the dynamic left leg and dynamic double-leg improved by 18.02% (t=8.20; p<.001; d=-1.37) and 16.68% (z=2.50; p<.001; d=-1.52), respectively. The consistent decreases in balance index scores, combined with large effect sizes across all variables, indicate that the six-week BOSU ball training program produced substantial gains in balance performance among all participants.

DISCUSSION AND CONCLUSION

This study investigated the effects of a six-week BOSU ball training program on static and dynamic balance performance in elite volleyball players. The results demonstrated significant improvements in all balance parameters for both male and female athletes, with large effect sizes indicating substantial adaptation within a short time frame. While these findings highlight the potential benefits of BOSU-based instability training, the underlying mechanisms should be interpreted cautiously, as proprioceptive, vestibular, and neuromuscular adaptations were not directly measured in this study. Therefore, the explanations provided below should be considered hypothetical rather than definitive.

Research on instability training commonly suggests that improvements in balance performance may stem from enhanced proprioceptive acuity, increased activation of stabilizing muscle groups, and refined sensorimotor coordination (Gidu et al., 2022; Yoon et al., 2022). The large effect sizes observed in parameters such as static and dynamic right-leg balance in both male and female athletes may be consistent with such potential neuromuscular adaptations. Previous studies have also proposed that unstable-surface exercises can increase reliance on sensory feedback processes and potentially improve integration of visual and vestibular cues (Ketterer et al., 2024). However, because the present study did not assess proprioceptive sensitivity, muscle activation patterns, or vestibular contributions directly, these interpretations remain speculative. Future studies that incorporate electromyography, force plate analyses, or proprioceptive threshold assessments would help clarify the mechanisms involved.

The improvements observed in male athletes align with earlier research reporting that instability-based exercises contribute to enhanced postural control and motor coordination in volleyball players (Achilleopoulos et al., 2022; Keller et al., 2023). Similar findings have been documented in female athletes, where balance and proprioceptive training were shown to improve dynamic stability and visual-motor control (Coelho-Oliveira et al., 2023; Yazgan et al., 2023). These parallels support the possibility that BOSU training may facilitate balance improvements across genders. Nevertheless, not all studies have reported uniformly positive outcomes. For example, Behm et al. (2023) noted that the effectiveness of unstable-surface training may vary depending on training duration, prior athletic experience, and the specificity of tasks used during testing. Lesinski et al. (2015) also highlighted that balance-related adaptations can differ based on training intensity and progression, indicating that short-term interventions may not always yield strong or consistent improvements.

Some research has further suggested that instability training may produce smaller effects in highly trained athletes, particularly those who already possess well-developed neuromuscular control (Prieske et al., 2016). Methodological concerns-such as variability in device types, unfamiliarity with instability tools, or insufficient training dose-have also been cited as reasons for inconsistent findings in the literature. Including such contrasting perspectives provides a broader scientific context and emphasizes that the improvements in the present study, although meaningful, may not generalize across all populations or training conditions.

Taken together, the results of this study demonstrate notable improvements in balance performance following six weeks of BOSU training in elite male and female volleyball players. While these findings are promising, the mechanisms proposed to explain these improvements should be regarded as potential pathways rather than direct causal relationships, given that they were not empirically tested. Additionally, differences in training background, adaptation rates, and methodological factors reported in other studies indicate that balance training outcomes can vary. Therefore, although instability-based exercises appear to offer meaningful benefits, further research incorporating mechanistic measurements and controlled comparative designs is recommended to substantiate the underlying processes and enhance the generalizability of the findings.

The present study examined the effects of a six-week BOSU ball exercise program on the static and dynamic balance performance of elite volleyball players and identified significant improvements in all measured balance parameters for both male and female athletes. These findings indicate that BOSU-based instability training may contribute to meaningful enhancements in balance performance within a relatively short training period.

While the literature frequently associates instability training with factors such as proprioceptive efficiency, neuromuscular adaptation, and improved postural control, it is important to note that these mechanisms were not directly assessed in this study. Therefore, such explanations should be considered as potential and theoretical interpretations rather than definitive conclusions.

Overall, the results suggest that BOSU ball exercises can serve as a beneficial component of volleyball training programs aimed at improving balance-related performance outcomes. Future studies incorporating direct mechanistic measurements are recommended to more clearly determine the underlying processes responsible for these improvements.

Recommendations

- BOSU ball exercises may be integrated into volleyball training programs 2-3 times per week, with sessions lasting 20-25 minutes, using moderate intensity instability tasks.
- Pre-season preparation periods may include progressive BOSU protocols consisting of single-leg balance tasks, dynamic weight-shifting drills, and core stabilization exercises to enhance overall balance proficiency.
- Future studies should examine the long-term effects of BOSU-based training by implementing different frequencies (2-4 days/week), varying intensities, and longer intervention durations.
- Comparative research involving athletes of different ages, genders, and competitive levels may help determine population-specific responses to instability training.
- The impact of BOSU ball exercises on other motor performance components-such as strength, agility, reaction time, and vertical jump ability-should be evaluated in future investigations.
- Electromyographic (EMG) analyses are recommended to better understand muscle activation patterns and neuromuscular responses during instability-based exercises.
- The potential role of BOSU ball exercises in injury prevention and rehabilitation programs should also be explored through controlled and longitudinal research designs.

Limitations

- The sample size of the study (n=36) was relatively small; studies with larger participant groups may enhance the generalizability of the findings.
- The intervention period was limited to six weeks; thus, the long-term sustainability of the observed effects could not be evaluated.
- Since all participants were elite volleyball players, the findings may not be directly generalizable to athletes from other sports or to amateur populations.
- Balance assessments were conducted solely under laboratory conditions and were not correlated with on-court performance measures.
- Participants’ daily lifestyle factors, such as nutrition and sleep habits, were not controlled, which may have indirectly influenced performance outcomes.
- No follow-up (post-test retention) measurements were performed; therefore, the persistence of the effects of BOSU ball training could not be determined.
- The study did not include a control group, which limits the ability to attribute observed improvements solely to the BOSU intervention and reduces internal validity.

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Literature Review	Burak YÜCEL
Data Collecting	Burak YÜCEL
Data Analysis	Burak YÜCEL
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Statement of Ethics Committee	
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Statement of Conflict	
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