

ผลของการฝึกด้วยลูกบอล BOSU ต่อความแข็งแรงของกล้ามเนื้อแกนกลางลำตัว
ของนักศึกษาวิทยาลัยอาชีวศึกษาหunanซานอี มณฑลหุนาน
THE EFFECTS OF BOSU BALL TRAINING ON CORE STRENGTH AMONG STUDENTS OF
HUNAN SANY VOCATIONAL AND TECHNICAL COLLEGE IN HUNAN PROVINCE

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลของการฝึกด้วยลูกบอล BOSU ต่อความแข็งแรงของกล้ามเนื้อแกนกลางลำตัวในกลุ่มนักศึกษาวิทยาลัยอาชีวศึกษาและเทคนิคหุนานซานอี มณฑลหุนาน ประเทศจีน โดยใช้ระเบียบวิธีแบบกึ่งทดลอง กลุ่มตัวอย่างประกอบด้วยนักศึกษาชั้นปีที่ 1 จำนวน 60 คน ซึ่งได้มาจากการสุ่มโดยใช้โปรแกรม G*Power เพื่อคำนวณขนาดกลุ่มตัวอย่าง และแบ่งออกเป็น 2 กลุ่ม ได้แก่ กลุ่มทดลอง (n = 30) ที่ได้รับการฝึกด้วยลูกบอล BOSU และกลุ่มควบคุม (n = 30) ที่ได้รับการฝึกกล้ามเนื้อแกนกลางตามรูปแบบปกติของการจัดการเรียนการสอนวิชาพลศึกษา สถานศึกษา ทั้งสองกลุ่มได้รับการทดสอบก่อนและหลังการทดลอง โดยใช้แบบทดสอบการยกขาข้างเดียวภายใน 1 นาที และการลุกนั่งภายใน 1 นาที เพื่อประเมินความแข็งแรงของกล้ามเนื้อแกนกลางลำตัว ก่อนและหลังเข้าร่วมการฝึกเป็นระยะเวลา 8 สัปดาห์ ข้อมูลที่ได้ถูกวิเคราะห์ด้วยสถิติเชิงพรรณนา และการทดสอบค่าที (t-test) ผลการวิจัยพบว่า กลุ่มทดลองมีคะแนนความแข็งแรงของกล้ามเนื้อแกนกลางเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ($p < .05$) หลังจากการฝึก เมื่อเปรียบเทียบกับคะแนนก่อนการทดลอง นอกจากนี้ การเปรียบเทียบผลหลังการทดลองระหว่างกลุ่มทดลองและกลุ่มควบคุมพบว่า การฝึกด้วยลูกบอล BOSU มีประสิทธิภาพเหนือกว่าอย่างมีนัยสำคัญทางสถิติในการพัฒนาสมรรถภาพทางกาย โดยเฉพาะความแข็งแรงของกล้ามเนื้อแกนกลางลำตัว ผลการวิจัยในครั้งนี้ชี้ให้เห็นว่าการ บูรณาการการฝึกด้วยลูกบอล BOSU เข้ากับการฝึกการออกกำลังกายประจำของนักศึกษาสามารถเป็นแนวทางที่มีประสิทธิภาพในการส่งเสริมสมรรถภาพของกล้ามเนื้อแกนกลาง และอาจมีประโยชน์ต่อสมรรถภาพทางกายโดยรวม รวมถึงการป้องกันการบาดเจ็บในกลุ่มนักศึกษาอาชีวศึกษา

คำสำคัญ: การฝึกด้วยลูกบอล BOSU, ความแข็งแรงของกล้ามเนื้อแกนกลาง, สมรรถภาพทางกาย, นักศึกษาระดับอุดมศึกษา, การวิจัยกึ่งทดลอง

Abstract

This study aimed to investigate the effects of BOSU ball training on core strength among students of Hunan Sany Vocational and Technical College. A quasi-experimental research design was employed, involving 60 first-year college students. Random sampling using G*power program to calculate the sample group. Participants were randomly assigned into two groups: an experimental group (n=30) that received BOSU ball training, and a control group (n=30) that followed conventional core strength training routines. Both groups underwent pre and post-tests evaluating core strength by one-minute leg raise test and one-minute sit-up test at baseline and after an 8-week training intervention. Data were analyzed using t-tests and descriptive statistics. The findings revealed statistically significant improvements ($p < .05$) in the experimental group's core strength after the training period, compared to their pre-test scores. Moreover, post-test comparisons between the experimental and control groups showed that BOSU ball training was significantly more effective in enhancing physical fitness components, particularly core muscle strength. These results suggest that incorporating BOSU ball exercises into regular training programs can be an effective method for improving core stability among college students, potentially benefiting their overall physical performance and injury prevention.

Keywords: BOSU ball training, Core strength, Physical fitness, College students, Quasi-experimental research

Introduction

Physical fitness is a fundamental pillar of holistic health, particularly among university students who are navigating a critical stage of physical, emotional, and cognitive development. In this population, core muscle strength—a central component of overall fitness—plays a vital role not only in enhancing athletic performance but also in supporting postural stability, injury prevention, and functional daily movements. Core muscles, including the transverse abdominis, multifidus, erector spinae, and obliques, serve as the stabilizing center of the body and are essential for maintaining spinal alignment and transferring force during movement (Kibler et al., 2006).

However, lifestyle factors associated with modern student life—such as prolonged sitting, sedentary leisure activities, and inadequate participation in structured physical education—have been shown to contribute significantly to core muscle weakness. This muscular deconditioning is linked to postural imbalances, reduced movement efficiency, and increased susceptibility to musculoskeletal disorders. Moreover, weak core strength undermines performance in both general physical activities and sport-specific skills, particularly those requiring dynamic balance, agility, and coordinated movement patterns. Given these concerns, there is a growing consensus that enhancing core strength should be a priority within university fitness programs. Interventions targeting core muscle development are not only relevant for athletes but are also crucial for promoting functional health in the broader student population. Integrating scientifically supported tools such as the BOSU ball into training protocols offers an innovative and practical solution to combat lifestyle-induced physical decline while fostering long-term health and performance benefits.

Several recent experimental studies have begun to address the gap by examining the effects of BOSU-ball or similar unstable surface training specifically within collegiate athlete populations. For instance, Dhamodharan et al. (2025) conducted an experimental study among university cricket players and found that a 6-week intervention of BOSU ball exercises significantly improved core stabilization ($p < 0.01$), outperforming Pilates in both static and dynamic balance assessments, as well as core endurance as measured by the McGill Core Endurance Test. Similarly, Yee et al. (2023) evaluated the effects of an 8-week proprioceptive training protocol using a BOSU balance trainer among competitive young rhythmic gymnasts. The results showed statistically significant improvements in core strength measured by side-bridge tests ($P < 0.001$ right, $P = 0.038$ left) when compared to a control group. Although static balance improvements were not observed, the study supports the efficacy of BOSU-based training in enhancing core strength within athlete populations.

Moreover, a systematic review by Oliva-Lozano et al. (2020) synthesized evidence across healthy adults using electromyographic (EMG) analyses and found that exercises performed on unstable surfaces (including BOSU balls) produce greater activation in core musculature internal and external obliques, transversus abdominis, erector spinae. Although the review generally included non-athletic adults, certain studies within it involved participants with sport backgrounds, and the findings highlight the potential application in athletic and collegiate populations. Together, these studies suggest that while much of the earlier literature focused on general or rehabilitation populations, there is growing and robust evidence that BOSU-based core training programs are effective in improving core strength, balance, and functional stability among university athletes. This provides a stronger empirical foundation for the current study to investigate core strength outcomes in a collegiate sports training context.

The BOSU ball also facilitates functional strength training and fat loss, often being integrated into High-Intensity Interval Training (HIIT) protocols that improve both aerobic and anaerobic capacities. The American Council on Exercise (ACE) has confirmed that BOSU-enhanced HIIT can increase fat-burning efficiency by 25% compared to steady-state aerobic exercise. These findings suggest that the BOSU ball is not merely an accessory, but a scientifically supported tool for improving physical fitness among college students. Research by Behm & Colado (2012) highlighted that instability training, such as using a BOSU ball, effectively activates core musculature and enhances neuromuscular control, leading to better functional performance. Moreover, Saeterbakken & Fimland (2012) found that BOSU-based exercises significantly increase muscle activation in the trunk and lower extremities compared to traditional floor exercises, making it a valuable modality in sports performance and injury prevention. Consequently, the BOSU ball holds potential as an effective intervention for reversing the decline in physical competency and promoting sustainable health practices in the academic environment.

Despite growing empirical support for BOSU ball training in general fitness enhancement, limited research has specifically examined its effect on core strength development and functional performance such as three-point shooting accuracy among university-level student-athletes. Most previous studies have focused on general populations or rehabilitation contexts, leaving a gap in the literature regarding how

targeted core training, such as that using BOSU balls, can be applied in collegiate sports training programs. This gap is particularly critical given that core strength plays a fundamental role in postural control, movement efficiency, and athletic performance. In sports like basketball, where explosive movements, balance, and dynamic stability are essential, core strength directly influences skills such as shooting accuracy, agility, and injury prevention.

Despite the increasing popularity of BOSU ball training in fitness and rehabilitation settings, there remains a significant gap in the literature regarding its targeted application for enhancing core strength and sport-specific functional performance among university students. Most existing studies have either focused on general populations or clinical populations, with limited emphasis on collegiate students engaged in structured physical education programs. Furthermore, few studies have examined the transferability of BOSU-based core training to athletic skill development, such as balance, coordination, and performance in dynamic sports activities. This study, therefore, aims to address this research gap by specifically investigating the effects of BOSU ball training on core strength among university students, a population that represents both emerging adulthood and a critical phase for physical competency development. By evaluating changes in core strength before and after a structured BOSU training intervention, the research seeks to provide empirical evidence supporting the inclusion of instability-based training into college-level fitness programs. To achieve this, the study has two primary objectives: (1) to examine the effects of BOSU ball training on the core muscle strength of students at Hunan Sany Vocational and Technical College in Hunan Province, and (2) to compare the levels of core muscle strength before and after undergoing BOSU ball training. The findings are expected to contribute not only to the academic body of knowledge but also to the practical design of physical education curricula and athlete conditioning programs. Moreover, the results could inform coaches, trainers, and educators on evidence-based methods for integrating core-strengthening protocols into routine training, thereby promoting sustainable physical performance outcomes in the collegiate population.

Research Methodology

This study employed a quasi-experimental design using a pre-test and post-test control group model to investigate the effects of BOSU ball training on core strength among college students. The research aimed to assess both the efficacy of BOSU ball training and its comparative effects against traditional core training methods.

Population

The population of this study consisted of 3,500 first-year students enrolled at Hunan Sany Vocational and Technical College, located in Hunan Province, China.

Sample

The participants were 60 first-year college students from Hunan Sany Vocational and Technical College. Two intact classes were selected using cluster sampling. The students were randomly assigned to either an experimental group ($n = 30$) or a control group ($n = 30$). The experimental group underwent BOSU

ball circuit training, while the control group engaged in traditional core strength exercises. All participants were screened to ensure they were healthy, free from injuries, and had similar baseline characteristics in terms of age, height, weight, and general physical fitness.

Research Instruments

The research instruments employed in this study consisted of the following:

1. Core Strength Tests – These included physical performance assessments aimed at measuring core muscle strength. Two standardized tests were used: One-Minute Leg Raise Test and One-Minute Sit-Up Test
2. BOSU Ball Circuit Training Program – A systematically designed training program utilizing progressive overload principles and instability-based core exercises to enhance participants' core strength over an 8-week intervention period.
3. BOSU Ball – An exercise device used as the primary equipment for training in the experimental group. The BOSU (Both Sides Up) ball is a half-sphere balance trainer designed to promote core muscle activation, proprioception, and postural control during physical training

Data Collection

The data collection process in this study was conducted through the following steps:

1. Preparation Phase

Prior to data collection, approval was obtained from the relevant authorities and informed consent was collected from all participants. The research objectives, procedures, and potential benefits were clearly explained to ensure voluntary participation. Research assistants were trained to perform standardized test administration and data recording to ensure consistency and reliability across all measurements.

2. Pre-Test Assessment

Before the intervention, both the experimental and control groups underwent pre-test assessments to evaluate baseline core strength. Two standardized physical performance tests were administered:

2.1 One-Minute Leg Raise Test: Participants performed as many leg raises as possible in a supine position within one minute.

2.2 One-Minute Sit-Up Test: Participants completed as many correct sit-ups as possible in one minute, with assistance in ankle stabilization provided by a partner. All pre-test data were recorded and used as baseline indicators for later comparison.

3. Intervention Phase (8 Weeks)

During the eight-week intervention period, the two groups followed different training protocols:

The experimental group participated in a BOSU Ball Circuit Training Program, conducted three times per week (Monday, Wednesday, and Friday), with each session lasting approximately 50 minutes. The training included instability-based exercises targeting core musculature.

The control group engaged in a traditional core training curriculum as prescribed in the college's physical education program. Both groups were supervised by instructors with equivalent qualifications to

control for instructional bias. All training sessions were conducted under controlled environmental conditions at the college stadium.

4. Post-Test Assessment

Upon completion of the eight-week training period, both groups underwent post-test assessments using the same core strength tests as in the pre-test phase. Testing procedures were kept consistent in terms of time, environment, and facilitation to ensure the validity of post-test data.

5. Data Recording and Analysis

All data were systematically recorded and categorized for statistical analysis. Core strength scores from both pre- and post-tests were compared within groups and between groups. The data were analyzed using descriptive statistics and independent sample t-tests to determine the effectiveness of the BOSU ball training program on core strength development.

Data Analysis

1. Data were collected before and after the 8-week training period for both groups using standardized test protocols.

1.1 Descriptive statistics (mean, standard deviation) were used to summarize participant characteristics and test results.

1.2 Inferential statistics were applied using paired-sample t-tests to examine within-group changes and independent-sample t-tests to compare between-group differences.

1.3 Pearson correlation analysis was conducted to examine the relationship between improvements in core strength. All statistical analyses were performed using SPSS software, with a significance level set at $p < .05$

Results

1. The comparison of the mean scores for core muscle strength between the experimental group and the control group prior to the BOSU ball training revealed no statistically significant difference at the .05 level. (Table 1.)

Table 1. Comparison of Pre-Test Core Strength between Experimental and Control Groups.

Variable	Indicator	Group	Mean $\pm$ SD	t	p
Core Strength	One-minute sit-ups	Experimental Group	35.27 $\pm$ 3.42	0.223	0.824
		Control Group	33.73 $\pm$ 3.44		
	One-minute supine leg raises	Experimental Group	28.27 $\pm$ 4.58	1.524	0.133
		Control Group	26.63 $\pm$ 3.66		

* $p < .05$ level

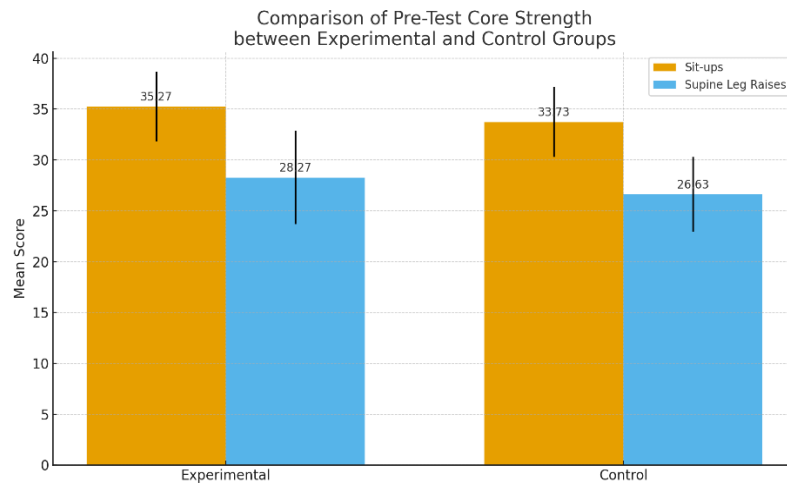


Figure 1. Comparison of Pre-Test Core Strength between Experimental and Control Groups

Summary based on the bar chart comparing Pre-Test Core Strength Results between the experimental and control groups.

Interpretation of the Pre-Test Bar Chart:

Sit-ups (1 Minute) The experimental group demonstrated a slightly higher average number of sit-ups (35.27 ± 3.42) compared to the control group (33.73 ± 3.44). However, the difference was not statistically significant ($p = .824$), indicating that both groups had similar abdominal muscle strength at the baseline.

Supine Leg Raises (1 Minute) The experimental group again showed a higher mean performance (28.27 ± 4.58) than the control group (26.63 ± 3.66). Nonetheless, this difference was also not statistically significant ($p = .133$), suggesting comparable lower abdominal strength before the intervention.

2. Comparison Between the Experimental and Control Groups

A comparison of post-test results between the experimental and control groups using independent sample t-tests revealed that the experimental group outperformed the control group in all test indicators, with statistically significant differences at the .05 level. (Table 2.)

Table 2. Comparison of Post-Test Core Strength between Experimental and Control Groups.

Variable	Indicator	Group	Mean $\pm$ SD	t	p
Core Strength	One-minute sit-ups	Experimental Group	39.57 ± 4.16	3.703	.000*
		Control Group	35.60 ± 4.13		
	One-minute supine leg raises	Experimental Group	36.77 ± 4.09	7.143	.000*
		Control Group	28.80 ± 4.52		

* $p < .05$ level

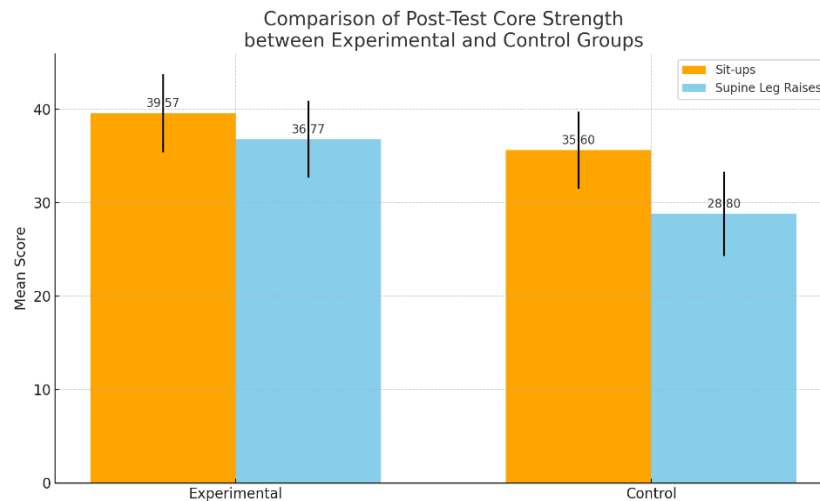


Figure 2. Comparison of Post-Test Core Strength between Experimental and Control Groups

Summary of Post-Test Results: BOSU Ball training effects on core strength. This bar graph presents the post-training comparison of core strength between the experimental group and control group based on two indicators: one-minute sit-ups and one-minute supine leg raises. Each bar shows the mean score with standard deviation as error bars.

Interpretation of the Results:

Sit-ups (1 Minute): The experimental group achieved a higher mean score (39.57 ± 4.16) compared to the control group (35.60 ± 4.13). Statistically significant difference ($p < .001$), indicating the BOSU ball training effectively improved abdominal muscle endurance.

Supine Leg Raises (1 Minute): The experimental group scored 36.77 ± 4.09 , notably higher than the control group (28.80 ± 4.52). Highly significant ($p < .001$), demonstrating enhanced lower core strength due to the intervention.

These findings provide strong evidence that BOSU ball training significantly enhances core muscle strength among college students, supporting its integration into physical education and athlete conditioning programs.

3. The comparison of core muscle strength scores before and after the experiment revealed that both the experimental and control groups demonstrated statistically significant improvements. The post-test mean scores for both groups were significantly higher than their respective pre-test scores at the .05 level (Table 3).

Table 3. Comparison of Pre-Test and Post-Test Core Strength within Experimental and Control Groups.

Group	Indicator	Pre-Test (M±SD)	Post-Test (M±SD)	t	p
Core Strength					
Experimental Group	One-minute sit-ups	35.27 ± 3.42	39.57 ± 4.16	-8.545	.001*
	One-minute supine leg raises	28.27 ± 4.58	36.77 ± 4.09	-9.520	.001*
Control Group	One-minute sit-ups	33.73 ± 3.44	35.60 ± 4.13	-2.980	.006*
	One-minute supine leg raises	26.63 ± 3.66	28.80 ± 4.52	-2.818	.009*

*p < .05 level. Statistical analysis was performed using Paired Samples t-test.

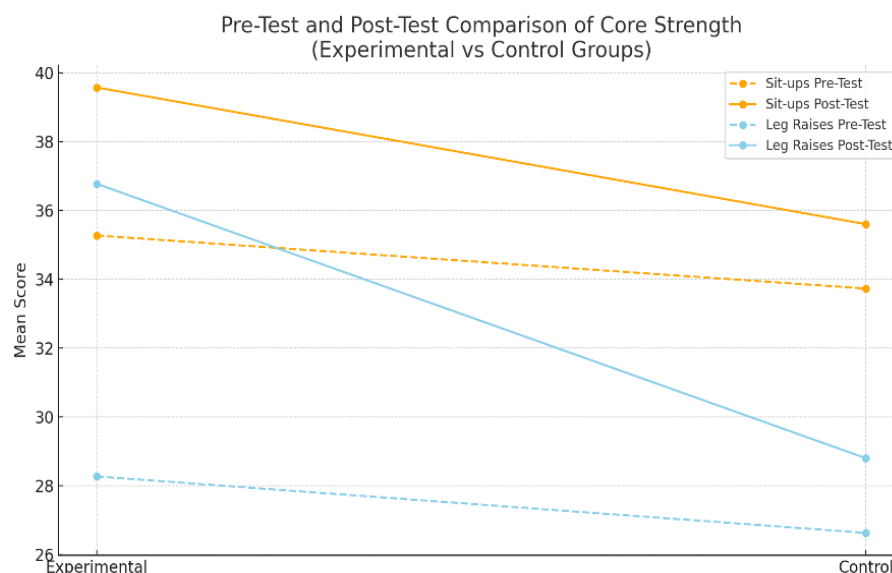


Figure 3. Pre-Test and Post-Test Comparison of Core Strength (Experimental vs Control Groups)

The line chart comparing pre-test and post-test scores for core muscle strength between the experimental and control groups across two indicators (Sit-ups and Supine Leg Raises). Summary of Findings from the chart experimental Group Sit-ups: Improved significantly from 35.27 to 39.57 repetitions and supine leg raises: Increased markedly from 28.27 to 36.77 repetitions. Both improvements were statistically significant at $p < .001$, indicating a strong effect of BOSU ball training. Control Group Sit-ups: Slight increase from 33.73 to 35.60. Leg raises: Small improvement from 26.63 to 28.80. Improvements were present but not as substantial, though still statistically significant at $p < .01$

Discussion

The present study confirmed that eight weeks of BOSU ball circuit training significantly enhanced core strength in college students. Specifically, the experimental group exhibited statistically significant

improvements in both the one-minute sit-up and supine leg raise tests compared to the control group (see Table 3.). This finding aligns with recent research demonstrating that unstable surface training such as that using BOSU balls enhances neuromuscular activation and core stability more effectively than stable surface methods. For example, instability resistance training has been shown to produce greater muscle activation and improved balance performance by challenging core stabilization systems (Gao et al., 2025) and These results support recent findings by Gong et al. (2023) For standing Long Jump: Given the absence of a significant impact of core reinforcement on this metric, coaches, and athletes might consider incorporating other methodologies, such as plyometrics or attentional focus strategies, into their training regimen. For the rebound Jump Index: Core reinforcement exercises should be strongly considered for inclusion in warm-up routines for martial arts athletes, given the substantial effect size observed. Moreover, the experimental group exhibited significantly better post-test outcomes than the control group (see Table 2.), reinforcing the facilitative effect of BOSU ball training on core strength. This outcome reflects broader findings from meta-analytic reviews showing that unstable surface training (STU) improves strength and balance performance in young adults compared to conventional control conditions (Behm et al., 2015). Notably, our results favor STU over traditional core training for enhancing core function and athletic performance in college-aged individuals.

The results of this study clearly demonstrate that BOSU ball training significantly enhances core muscle strength among college students. Participants in the experimental group who underwent an 8-week BOSU-based training regimen exhibited notable improvements in both one-minute sit-ups and one-minute supine leg raises, as compared to their pre-test scores and those of the control group. These improvements are statistically significant at the .05 level, reflecting the effectiveness of instability-based training protocols in activating deep muscle groups and enhancing neuromuscular coordination.

These findings are consistent with those reported by Yee et al. (2023), who investigated the effects of proprioceptive BOSU training among rhythmic gymnasts. The study showed a significant increase in core strength post-intervention, highlighting the functional benefits of BOSU-induced instability in improving trunk stability and strength. Although Yee et al.'s study focused on athletes, the results align with the present study in showing that unstable surface training stimulates core musculature more effectively than traditional stable surface activities.

Further supporting evidence comes from Dhamodharan et al. (2025), who compared BOSU ball training with Pilates exercises among university cricket players. Their findings revealed that the BOSU group achieved superior gains in core stabilization, suggesting that BOSU training can outperform other popular methods in targeting the deep core muscle groups. The authors emphasized the unique role of instability in triggering motor unit recruitment and enhancing proprioceptive responses.

In addition, a randomized controlled trial conducted by Gao et al. (2025) reinforced the notion that unstable surface training yields better outcomes in terms of core strength development. Adolescents who engaged in core workouts using BOSU and similar equipment experienced more substantial gains in muscular endurance and trunk activation than those trained on stable surfaces. These results reflect the

physiological demands of balance-based movement patterns that continually challenge the body's center of gravity. And is also consistent with the study of Prieske et al. (2016) The findings indicate significant improvements in trunk muscle strength and athletic performance in both groups when added to regular soccer training. However, the effects of CSTU were limited, possibly due to the high training status of the participants and the small volume of CSTU. The study also highlights the importance of considering neuromuscular factors and the transfer of training-induced adaptations.

Moreover, a systematic review and meta-analysis by (Behm et al., 2015). concluded that strength training using unstable surfaces promotes greater neuromuscular activation and physical adaptations than traditional training. This effect was particularly pronounced in dynamic core tasks, lending further credibility to the integration of BOSU training into physical education and athlete conditioning programs.

Taken together, the results of this study and corroborating research emphasize the substantial benefits of incorporating BOSU ball exercises into core strength regimens. The activation of stabilizing musculature, improved postural control, and enhanced trunk endurance observed in the experimental group validate BOSU ball training as a practical and scientifically supported strategy to improve core fitness among general student populations.

Conclusion and Suggestion

The findings of this study demonstrate that an eight-week BOSU ball training program significantly enhances core strength in college students. Post-test results revealed that the experimental group achieved superior performance in both one-minute sit-up and supine leg raise tests compared to the control group, with statistically significant differences at the .05 level. These results indicate that incorporating unstable-surface training, such as BOSU ball exercises, can effectively activate and strengthen the core musculature beyond what is achieved through traditional training methods.

A noteworthy contribution of this research is the identification of a positive relationship between core strength improvement and overall physical performance in a non-athlete college population. While previous studies have largely focused on elite athletes or specialized sports contexts, this study extends the evidence base to general college students, highlighting the applicability of BOSU ball training in broader educational and health-promotion settings.

The newly generated knowledge from this study underscores the value of integrating BOSU ball-based instability training into physical education curricula and recreational fitness programs to improve core stability, postural control, and functional movement. This approach can serve as an effective strategy for enhancing physical fitness, reducing injury risks, and fostering long-term exercise habits among young adults. Based on the findings, the following recommendations are made:

Recommendations from the Research Findings

Based on the findings of this study, the following recommendations are made:

1. Integration into Physical Education Programs Universities and colleges should consider incorporating BOSU ball-based core training protocols into regular physical education curricula. The results

demonstrated significant improvements in core strength, which are essential for enhancing overall physical fitness, reducing injury risk, and supporting athletic performance in students.

2. Application in Athlete Training Sports teams, particularly at the collegiate level, can adopt BOSU ball training to complement traditional strength programs. The instability-based exercises are beneficial for improving postural control, functional movement patterns, and sport-specific performance.

3. Progressive Training Design Future training programs should employ a progressive overload principle, gradually increasing exercise complexity and intensity to sustain performance gains and further stimulate neuromuscular adaptations.

4. Further Research on Balance Outcomes Given the mixed evidence regarding balance enhancement, additional studies should investigate the long-term effects of BOSU ball training on both static and dynamic balance across different populations, including those with varying baseline fitness levels.

5. Exploration of Injury Prevention Benefits Researchers and practitioners should explore the potential role of BOSU ball training in injury prevention, particularly for lower back and lower extremity injuries, as improved core stability may reduce biomechanical stress during sports and daily activities.

Recommendations for Future Research

1. Longitudinal Studies Future research should examine the long-term effects of BOSU ball training on core strength, balance, and other physical fitness components over extended periods, such as 16–24 weeks, to determine the sustainability of improvements.

2. Diverse Participant Populations Studies should include participants from various age groups, fitness levels, and athletic backgrounds to evaluate the generalizability of the findings beyond college students.

3. Comparative Training Modalities Further research could compare BOSU ball training with other unstable-surface tools (e.g., Swiss balls, balance boards) and traditional core training methods to determine relative effectiveness and optimal training strategies.

4. Inclusion of Additional Performance Metrics Future studies should incorporate additional performance indicators, such as agility, reaction time, or sport-specific skills, to explore the broader athletic benefits of BOSU ball training.

5. Biomechanical and Neuromuscular Analysis Using motion capture and electromyography (EMG) in future studies could provide deeper insights into the biomechanical and neuromuscular mechanisms underlying the observed improvements in core strength and balance.

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