Impact of Core Stability Training and Valsalva Maneuver on Balance and Specific Skills: A Comprehensive Study in College Soccer Players Within the Domain of Sports and Exercise Medicine

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Abstract

This study emphasises the importance of understanding the central role of the core in functions such as force transfer, spinal stability, injury prevention, and precise movement control. The importance of developing core muscles to maintain good posture, improve proprioception, and enhance body composition for overall well-being is emphasised. This study rigorously evaluates the effects of core stability training and Valsalva Maneuvers (VM) on the balance and specific skills of college football players. A random sample of around 90 soccer players from a polytechnic in Sichuan Province, China, was chosen. All participants had at least two years of experience playing soccer and were between the ages of 18 and 20 on average. Two interventions were randomly assigned to two groups, while a third group served as the control. To allocate subjects, the study used an equated group design and a random group design to assign treatments. The data was analysed using ANCOVA and mean variance methods, which showed significant differences between the initial and final means of the treatment groups compared to the control group.The results indicate a positive association between core stability training, Valsalva Maneuvers, and improved balance and specific skills in athletes. Individuals who engage in these training modalities demonstrate enhancements in balance, resilience, decision-making, stamina, concentration, and tolerance. The results of this study are consistent with previous research, highlighting the importance of core stability training and Valsalva Maneuvers in enhancing athletic performance.

Keywords: Football, Core Stability, Valsalva Maneuvers, ANCOVA, Balance Ability, Specific Skills, Sport Medicine.

Introduction

Sports training is a widely studied topic among sports professionals, including coaches, athletes, and strength and conditioning specialists, who seek to enhance performance. Sports professionals have recognized the importance of core fitness in sports performance. Most sports necessitate the transfer of force from the core to the limbs. During the act of throwing a baseball, the arm generates contralateral external oblique movements that stimulate muscle activation patterns (AkuthotaV, 2004). The functional kinetic chain governs limb movement, particularly the core. Enhancing core fitness benefits athletes by improving force generation, reinforcing spinal stability, and assisting in injury prevention and rehabilitation (Hilligan, 2008). The core structures encompass the passive structures found in the abdominals, para spinal and gluteal muscles, hip girdle musculature, and pelvic floor. These structures actively contribute to the strength and stability of the trunk musculature (Willson et al., 2005).

Core stability refers to the body's ability to maintain or regain a stable trunk position through neuromuscular control in response to internal and external forces during perturbation. Transferring, creating, and controlling force and motion to the ends of the kinetic chain is what dynamic trunk control is all about (Kibler et al., 2006). Neuromodulation enables coordinated muscle contractions, ensuring adequate motor control of the joints. This control ensures sufficient joint compression through the articular structures. This model proposes an integrated approach to understanding joint function (Nesser & Lee, 2009). The importance of developing core muscles is evident in a variety of functional and athletic activities that improve stability in the core and proximal regions, thereby enabling greater mobility in the distal regions. Appropriate timing and tensioning of core muscle contraction can enhance the optimal stability of deeper and superficial core muscles (McGill, 2010). An athlete who focuses solely on training their leg muscles exhibits lower performance compared to an athlete who incorporates training of the core muscles (abdominal and

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upper body muscles). This results in improved dynamic balance and coordinated movement, enhancing sprint performance. This study assesses the impact of core stability training and Valsalva Maneuvers (VM) on the balance and specific skills of college football players.

Core stability is defined as the training of the lumbopelvic and abdominal regions. The concept of core stability was defined by combining a local and global stability system (Behm et al., 2002). Achieving the correct body composition through diet and exercise can lead to an improved sense of well-being and quality of life. Implementing these practices can improve stress management in life. Body fat and lean body weight are the two main components of body composition. Anthropometric parameters are commonly employed to measure various body composition variables. The following are the variables that help in understanding body composition:

Table 1

Variables of Body Composition

No	Variable of Body Composition
1	Body Mass Index
2	Body Surface Area
3	Body Fat%
4	Absolute Total Body Fat
5	Essential Fat Mass
6	Non-Essential Mass
7	Lean Body Mass
8	Fat-Free Body Mass
9	Bone Mass
10	Bone Density

The role of body composition in athletic performance is crucial. Improved body fat and lean body mass management through exercise is crucial for both sedentary individuals and athletes, as it decreases body fat and increases lean body weight. Existing literature suggests that fat-free body weight plays a significant role in activities that contribute to improved physical performance (McArdle et al., 2006). An individual's core quality also affects their physical fitness. Physical fitness is the capacity of an individual to effectively perform their daily activities and have sufficient energy to handle unexpected situations. Physical fitness encompasses multiple components, including strength, endurance, flexibility, balance, and coordination ability. Flexibility is the capacity to perform movements with a wider range or amplitude. Flexibility is sometimes synonymous with stretchability, elasticity, suppleness, and mobility. The muscles and ligaments possess unique properties of stretchability and elasticity. These qualities enable the tissue to restore its original length without any impact.

Sports training employs specialized methods and techniques to prepare and structure athletes for sporting success. In addition to traditional forms of training, athletes encounter a variety of training methods, such as:

a. Core Training
b. Cross-training
c. Boxing training
d. Altitude training
e. Endurance training
f. Fartlek training

LiteratrureReview

In recent years, the field of sports training has experienced significant transformations. Various new approaches have facilitated the traditional method of training. In order to excel in sports, it is imperative for sports trainers, coaches, and athletes to comprehend and implement the emerging concepts and approaches. Core training is a new and widely accepted approach to sports training. It aims to enhance strength, stability, sports techniques, and injury prevention. Core training offers various benefits, including improved posture and enhanced performance. Proper posture is crucial for both daily activities and high-level athletic performance. The antigravity muscles are core muscles that are crucial for maintaining athletic performance (Luo et al., 2022). The core is crucial, as it houses the centre of gravity and serves as the origin of movement. Maintaining posture during functional activities is crucial to prevent improper posture and movement due to an unstable core. Researchers report that static postural alignment facilitates appropriate and anticipatory postural activity of the feed-forward system (Saeterbakken et al., 2022).

A VM can effectively increase respiratory rate, leading to a longer duration of resistance in myocardial cells, which helps to terminate the established nodal reentry circuit. Historically, people have used the technique of expiring against a closed glottis to elevate arterial pressure by stimulating baroreceptors and enhancing vagal tone. However, uncontrolled vagal activation can lead to adverse effects, including increased intraocular pressure and significant hypotension (GambataV, 1999).

A study was conducted to examine the impact of medicine ball training on fitness performance (ClarkM, 1998). The findings indicated that medicine ball training led to significant improvements in various fitness variables, including flexibility, shuttle run, long jump, abdominal curl, medicine ball toss, and medicine ball push-up performance. Core strengthening enhances strength, performance, neuromuscular control in work settings, and sports performance techniques (Segal et al., 2004). Researchers (Faigenbaum et al., 1996) conducted a study that compared eight Swiss ball exercises with two traditional abdominal exercises. The study found that the rollout and pike exercises were particularly effective in activating the upper and lower rectus abdominals, external and internal oblique, and latissimus dorsi muscles. Researchers also observed that these exercises reduced the activity in the lumbar paraspinal and rectus femoris muscles. Core stability training was investigated by Roetert (2001) as a means to adapt conventional resistance exercises for use in sports conditioning programmes. The suggested modifications include transitioning from stable to unstable surfaces, replacing sitting exercises with standing exercises, and substituting machines with free-weight exercises.

This study examines the impact of resistance training on the daily quality of life, functional status, and health of older adults. Sarcopenia and loss of strength are common issues in older individuals (Escamilla et al., 2010). A review article by Willardson (2007) examined the effects of comprehensive training on trunk and hip muscles. The study concluded that specific core stability training has a limited impact on athletic performance. Nevertheless, multiple studies have presented conflicting findings, indicating a lack of uniformity in outcome measurement.

Patients with mechanical, nonspecific low back pain, both athletic and non-athletic, received core stability training (Hunter et al., 2004). The neuromuscular system's ability and functional strength rely on core strength. The core muscles play an important role in force reduction, force production, kinetic chain dynamics stabilization, and protection against unwanted functional movement forces. (Jago et al., 2006) The author emphasized the importance of training to cultivate a robust and stable core. Integrating a small number of core training exercises into the existing programme can decrease the likelihood of injury and improve overall performance. Strength training's primary goal is to increase the rate of force development. Additionally, we can implement specific training goals to promote hypertrophy and enhance maximal strength. Functional and specific core training movements can result in optimal sports performance (MehrboniH et al., 2010).

This study examined the core stability of three groups of football players, consisting of two male groups and one female group. Regarding trunk flexors endurance, there were no significant differences found between groups. However, female players exhibited a significantly higher flexors-to-extensors ratio, suggesting that women may have greater trunk extensors endurance. The user's text is already concise and does not require any rewriting. A study involving 15 core exercises for school children found that core training enhances students' fitness level, including balance and posture, resulting in improved movement and performance (Handze, 2003). The researchers also concluded that core training is suitable for all students. The suggested approach for training core musculature, as proposed by Behm et al. (2002), is to prioritise ground-based free-weight exercise lifts for both athletes and non-athletes. A literature survey found that core strength training is effective for improving sports performance and fitness. Nevertheless, due to the lack of existing literature in the Chinese context, scholars have undertaken this study to gain a deeper understanding of the fundamental training concept in China.

The development of core strength is critical for enhancing strength, enabling the neuromuscular system to generate force, and dynamically stabilising the kinetic chain. The core musculature provides protection against unwanted forces during functional movements (Handze, 2003). A study by Nikolaidis (2010) revealed that golf, volleyball, and other sports players can improve their performance skills through core training. Furthermore, core training enhances players' motion control and stability. A study by Pierce et al. (2007) corroborated the aforementioned findings, demonstrating that training led to improvements in physical fitness and athletic performance. Furthermore, this study encompasses three fundamental exercises: For athletes (Lee & McGill, 2017), mastering isometric contraction of the core muscles is critical. Additionally, performing slow contraction movements in a stable state (Watanabe et al., 2014) and engaging in static support with slow contraction under unstable conditions are also important exercises for athletes (Nelson-Wong et al., 2012). We conducted these exercises three times per week for a total of three weeks. The significance of core training for football players lies in the comprehensive approach required for optimal performance and injury prevention:

Mastering Isometric Contractions of Core Muscles

Football players greatly benefit from mastering isometric contractions of their core muscles. Isometric exercises simulate the stability required for tackles, sudden changes in direction, and maintaining balance while dribbling or jockeying for position with opponents. These exercises involve holding a position without movement (Nazmi et al., 2016). Core training improves a player's capacity to withstand external forces and maintain a stable core, reducing injury risk and promoting consistent performance (Rio et al., 2017).

Slow Contraction Movements under Steady State

The importance of slow and controlled core contraction movements for players mirrors the deliberate and controlled movements required on the football pitch (Pogosyan et al., 2009). The exercises mentioned are beneficial for enhancing muscle endurance and control, which are crucial for activities such as long-distance running, maintaining control of a ball, and executing accurate passes or shots. Steady-state contractions enhance the explosive power, finesse, and control required in football (Watanabe et al., 2014).

Static Support with Slow Contractions under Unstable Conditions

Football is a sport characterised by its dynamic nature, often played in unstable conditions where players must adapt to uneven terrain and unpredictable challenges. Integrating static support and slow contractions in core training, such as using a stability ball or wobble board, helps athletes prepare for real-world situations they face during sports (Arenas et al., 2012). This training method enhances balance, coordination, and core stability, enabling athletes to make rapid decisions and movements in a match.

The three core exercises in football training address various demands on players, including stability, resistance against external forces, endurance, control, and adaptability. A comprehensive core training programme enhances the performance and reduces the risk of injuries in football players by preparing them for physical and mental challenges.

Methods

The study described the selection of variables and subjects, formulation of the training programme, data collection process, data reliability, experimental design and organisation of test items, and statistical techniques used. Figure 1 illustrates the conceptual framework of this study.

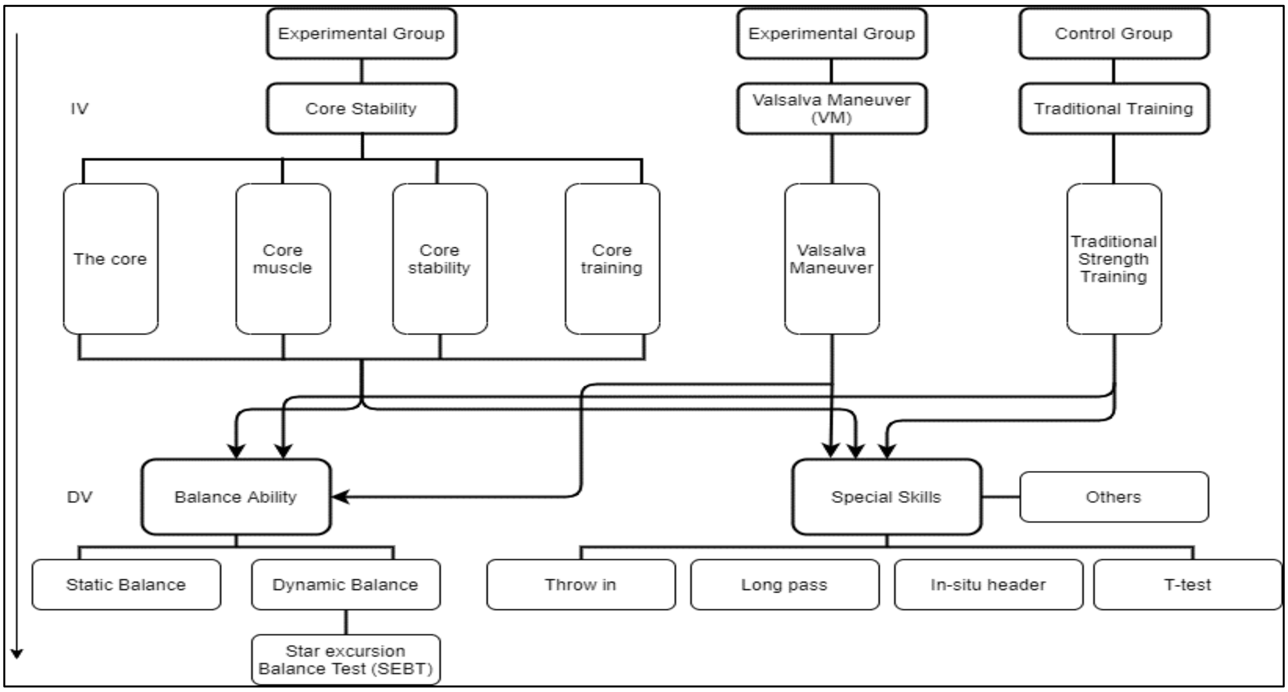

Figure 1: Conceptual Framework.

Selection of Subjects

This study, which took place between February and June 2022, randomly selected 90 football players from a polytechnic in Sichuan Province, China, as participants. All selected subjects had a minimum of two years of experience in competitive football. The participants' average age ranged from 18 to 20 years. The two treatment groups were randomly assigned, while the third group served as the control group, each consisting of 30 subjects. A consent form was obtained from each participant to ensure ethical compliance. The study includes a total of 73 male participants, 17 female participants, 31 participants aged 17 to 20, 46 participants aged 21 to 24, and 13 participants aged 25 years and older. In addition, 26 participants weigh between 51 and 55 kg, 49 participants weigh between 56 and 60 kg, and 15 participants weigh 61 kg or above. In the study, 28 participants had a height between 5.00" and 5.50", 51 participants had a height between 5.51" and 6.00", and 11 participants had a height of 6.01" or above. Table 2 presents the figures.

Table 2

Demographics of The Respondents

Sex			
	Male	Female	Total
	73	17	90
Age			
17 to 20 Years	21 to 24 Years	25 Years or above	Total
31	46	13	90
Weight			
51 to 55 Kg	56 to 60 Kg	61 or above Kg	Total
26	49	15	90
Height			
5.00” to 5.50”	5.51” to 6.00”	6.01” or above	Total
28	51	11	90

Ethical consideration

The study adhered to the Universiti Malaya Research Ethics Guidelines and received approval from the Universiti Malaya Research Ethics Committee (UMREC) with reference number UM.TNC2/UMREC_1422. Prior to the study, we obtained written informed consent from all adult participants. The consent form provided information on the study's objective, the voluntary nature of participation, and the guarantee of confidentiality. The study concealed all participant information.

Experimental Design

A equated group design was used to allocate subjects to different groups. A random group design was employed to allocate participants to the control and experimental groups. The Quasi-Experimental Design, also known as the Pre-test and Post-test Design, is depicted in Figure 2.

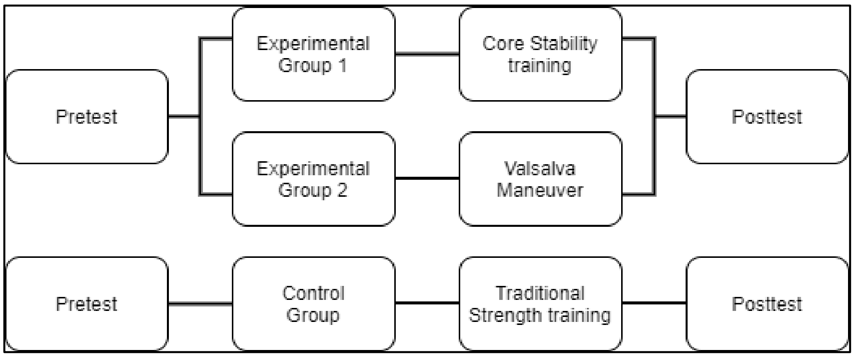

Figure 2: Pretest and Posttest Design.

Variables Selection

The following variables were selected for the study.

a. Left Leg Stances
b. Right Leg Stances
c. In-Situ Throw-In
d. One-Step Run and Kick Long Pass
e. In-Situ Header

Statistical Technique

Covariance analysis (ANCOVA) examines the impact of categorical variables on a continuous dependent variable, while accounting for the influence of specific continuous variables that are associated with the dependent variable (Sandrey & Mitzel, 2013). ANCOVA combines elements of ANOVA and linear regression, as it involves a linear model with a dependent variable of the same type and identical hypotheses (Reed et al., 2012). Let p represent the number of quantitative variables and q represent the number of factors, which include the qualitative variables and their interactions, the ANCOVA model is written as follows:

yi = β0 + ∑j=1...p βjxij + ∑j=1...q βk(i,j),j + εi(1)

Where yi is the value observed for the dependent variable for observation i, xij is the value taken by quantitative variable j for observation i, k(i,j) is the index of the category of factor j for observation i and εi is the model error.

Formulating Process of Training Program

The research scholar is a qualified football coach with a clear understanding of the training and coaching process. The researcher developed the training programme using his experience, literature from the library and internet, and expert opinions. The progressive training programme was formulated with consideration of the following basic concepts:

a. A good warm-up
b. Proper stretching and general mobilizing exercise of various joints and muscles.
c. Specific stretching and mobilizing exercises for respective muscle groups and joints.
d. Systemic progressive training program.
e. Good gradual cooling down program.

The training program comprises the following exercises: Systematic variations in their execution determined the intensity, load, and volume of the exercises. Table 3 displays the exercises included in the core stability training programme:

Table 3

List of Exercises in Core Stability Training Program.

No	List of Exercises	Sub-Category	Duration / Sets
1.	Master the Isometric Contraction of the Core Muscles. (3 weeks, 3 times a week)	i. Plank	(2 weeks, 3 times a week).
		ii. Side bridge	(30s × 3 sets× 2 sides)
		iii. Back bridge	(15s × 2 sets)
2.	Slow contraction movement under steady state (3 weeks, 3 times a week)	1. Improve Bird-dog	(10 times × 2 sets × 2 sides)
		2. Cat-camel	(10 times × 2 sets).
		3. Supine back bridge lifting legs	(5 times × 3 sets × 2 sides)
		4. Plank with hip dips	(10 times × 2 sets)
		5. Side Plank with hip dips	(10 times × 2 sets)
3.	Static support and slow contraction under unstable conditions (3 weeks, 3 times a week)	1. Stability ball knee tuck with push up	(5 times × 3 sets)
		2. V-sit pass the stability ball	(10 times × 2 sets)
		3. Stability ball wall squats	(10 times × 3 sets)
		4. Stability ball plank rollout	(5 times × 3 sets)
		5. Stability ball glute bridge	(10 times × 2 sets)
		6. Stability ball split squat	(5 times × 3 sets × 2 sides)
		7. Stability ball hamstring curl	(10 times × 2 sets)
		8. Leg rotation with stability ball	(10 times × 2 sets × 2 sides)

Table 4

List of Exercises in VMTraining Program

No	List of Exercises	Sub-Category	Duration / Sets
1.	Breathing exercise (2 weeks, 3 times a week)	1. Abdominal breathing	10 Minutes
		2. One to two breathing exercises	10 Minutes
2.	Valsalva Maneuver exercise	-	(3 weeks, 3 times a week)
3.	Abdominal breath resistance exercise (3 weeks, 3 times a week)	1. Abdominal breathing resistance exercise (pressing with both hands)	(1 week, 3 times a week, 10 min × 2 sets)
		2. Abdominal breathing resistance exercise (3 kg dumbbell)	(2 weeks, 3 times a week, 10 min × 2 sets).

Data Collection

Data on the impact of core stability training and VM training was collected from both the experimental and control groups. The participants were assigned to an eight-week training programme focused on core stability and VM training. Prior to the exercise programme, a pre-test was administered to evaluate the participants' condition.A post-test was conducted to assess the effects of the training programme. Figure 3 illustrates the data collection procedure.

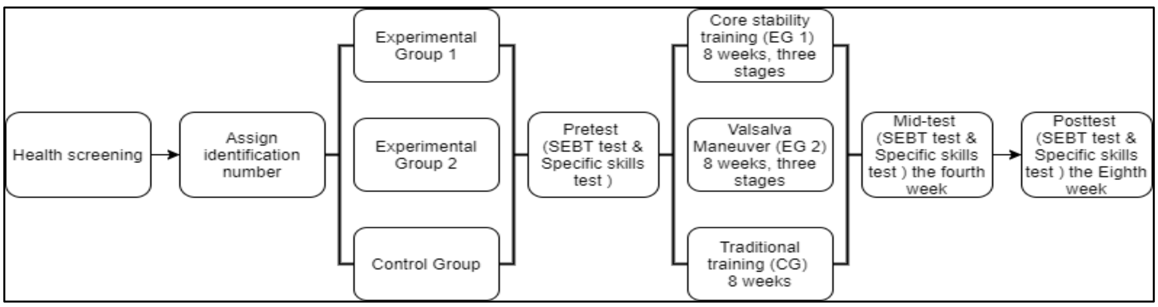

Figure 3: Data Collection Procedure for the Study.

Reliability of Data

The test-retest method was used to determine the reliability of the leg raise and hold test for evaluating lower abdomen strength and establishing specific norms.The reliability of the other test items was not necessary, as they are standard tests used to measure the respective variables.

Results

The data was analysed using the mean variance method to determine the significant difference between the initial and final means of the treatment and control groups. The results showed that the training programme led to a significant improvement in left leg stances for both experimental group A (core stability) and experimental group B (VM) compared to the control group.
The data was analysed using the mean variance method to determine the significant difference between the initial and final means of the treatment and control groups. The results showed that the training programme led to a significant improvement in left leg stances for both experimental group A (core stability) and experimental group B (VM) compared to the control group.
Figure 4 presents a comparison of the Initial Means, Final Means, and Adjusted Post-test Means for three groups: Treatment Group A, Treatment Group B, and Control Group. This comparison specifically examines the positions observed on the left leg.
The mean variances method was used to analyse Table 7 in order to determine the significant difference between the initial and final means of the treatments and control groups. The results showed that the training programme led to a significant improvement in right leg stances for both experimental group A (core stability) and experimental group B (VM), compared to the control group.

Table 5

Analysis of Covariance of the Means in Left Leg Stances

	Sample Size	Control Group	Experimental Group (A) - Core Stability	Experimental Group (B) - VM	SoV	SoS	df	MSS	F-ratio	η2
					A	498.63	2	249.32	1.29	0.043
Pre-Test	90	93.65	93.15	99.50	W	11014.10	87	193.23	(Sig 0.283)	4.30%
					Total	11512.73	89			
					A	16885.63	2	8442.82	45.08	0.612
Post test	90	94.55	134.55	122.70	W	10676.10	87	187.30	(Sig 0.000)	61.26%
					Total	27561.73	89			
					A	16606.59	2	8303.29	50.55	0.602
Adjusted Post Test	90	95.20	135.59	121.21	W	9197.74	86	164.25	(Sig 0.000)	60.25%
					Corrected Total	852650.00	60			
Gain Pre-Post (%)		0.96	44.44	23.32						

Table 6

Paired Means Difference on Left Leg Stances

Control Group	Experimental Group (A) Core Stability	Experimental Group (B) VM	Difference Required	Difference Obtained
95.2	135.39		3.18	40.19
9S5.2		121.21	3.18	26.01
	135.39	121.21	3.18	14.18

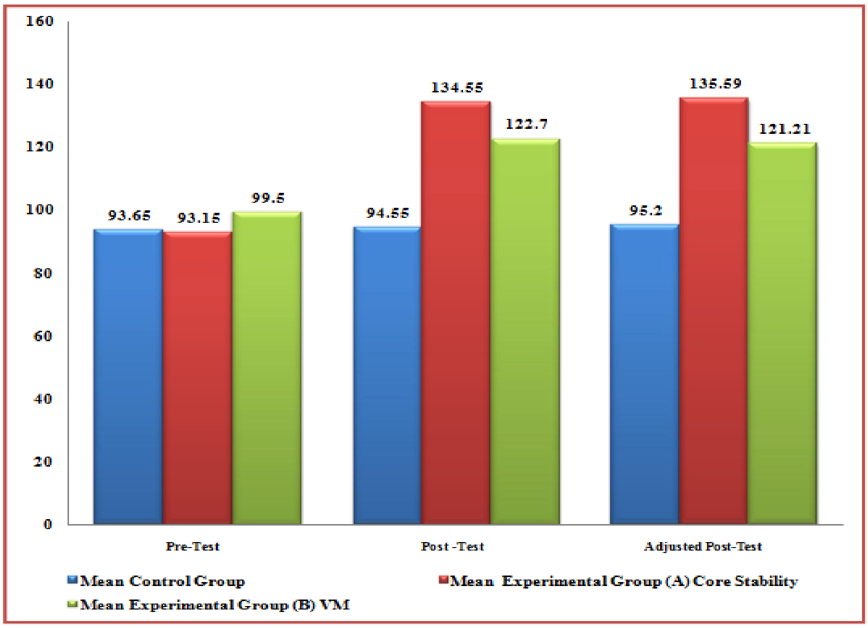

Figure 4: Comparison between Initial Means, Final Means and Adjusted Posttest Means of Treatment Group A, Treatment Group Band Control Groupon Left Leg Stances.

Table 7

Analysis of Covariance of the Means on Right Leg Stances

	Sample Size	Control Group	Experimental Group (A) - Core Stability	Experimental Group (B) - VM	SoV	SoS	df	MSS	F-ratio	η2
					A	9.23	2	4.62	1.033	0.0349
Pre-Test	90	10.40	10.05	9.45	W	254.70	87	4.47	(Sig 0.362)	3.49%
					Total	263.93	59			
					A	163.63	2	84.32	15.19	0.337
Post test	90	10.75	14.85	13.00	W	316.30	87	5.55	(Sig 0.000)	33.47%
					Total	484.93	89			
					A	180.69	2	90.35	18.02	0.372
Adjusted Post Test	90	10.59	14.82	13.19	W	280.75	86	5.01	(Sig 0.000)	37.26%
					Corrected Total	10418.00	60			
Gain Pre-Post (%)		3.36	47.76	37.56						

Table 8 shows that the mean difference between treatment group A (core stability) and treatment group B (VM) is 1.63, which is significantly greater than the required value of 1.00. The results indicated a significant improvement in the mean difference of core stability and VM between experimental groups A and B compared to the control group in right leg stances.

Table 8

Paired Means Difference on Right Leg Stances

Control Group	Experimental Group (A) Core Stability	Experimental Group (B) Vm	Difference Required	Difference Obtained
10.59	14.82		1.00	4.23*
10.59		13.19	1.00	2.9*
	14.82	13.19	1.00	1.63*

Figure 5 presents a comparison of the Initial Means, Final Means, and Adjusted Posttest Means for three groups: Treatment Group A, Treatment Group B, and Control Group. The comparison focuses on the right leg's observed stances.

The mean variances method was used to analyse Table 9 in order to determine the significant difference between the initial and final means of the treatments and control groups. The results showed that the training programme had a significant positive effect on the In-Situ Throw-In performance of players in both experimental groups A (core stability) and B (VM), compared to the control group.

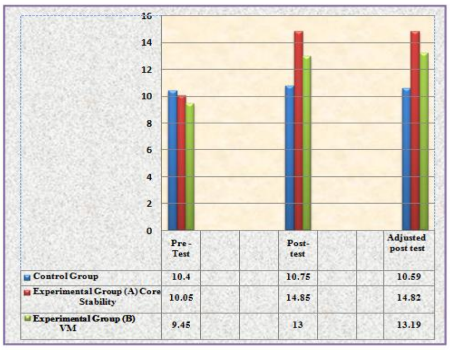

Figure 5: Comparison between Initial Means, Final Means and Adjusted Posttest Means of Treatment Group A, Treatment Group Band Control Groupon Right Leg stances.

Table 9

Analysis of Covariance of the Means in In-Situ Throw-In

	Mean									
	Sample Size	**Control Group**	**Experimental Group (A) - Core Stability**	**Experimental Group (B) - VM**	**SoV**	**SoS**	**df**	**MSS**	**F-ratio**	**η2**
					A	780.40	2	390.20	1.22	0.040
Pre-Test	90	81.20	81.30	88.90	W	18313.20	87	321.28	(Sig 0.304)	4.08%
					Total	19093.60	89			
					A	14759.03	2	7379.52	42.62	0.599
Post-test	90	82.90	104.65	121.20	W	9869.55	87	1713.15	(Sig 0.000)	59.93%
					Total	24628.58	89			
					A	12422.15	2	6211.08	47.65	0.504
Adjusted Post Test	90	83.87	105.59	119.29	W	7299.92	86	130.36	(Sig 0.000)	50.40%
					Corrected Total	660139.0 0	60			
Gain Pre-Post (%)		2.09	28.72	36.33						

Table 10 shows that the mean variance between treatment group A (core stability) and treatment group B (VM) is 13.7, which is significantly higher than the required value of 3.09. In terms of in-situ throw-in, the results demonstrated a significant improvement in the critical mean difference between the experimental groups A (core stability) and B (VM) compared to the control group. This indicates that the training programme had a positive impact on the participants' performance.

Figure 6 presents a comparison of the Initial Means, Final Means, and Adjusted Post-test Means for Treatment Group A, Treatment Group B, and Control Group. The comparison specifically examines the In-Situ Throw-In technique.

Table 10

Paired Means Difference on In-Situ Throw-In

Control Group	Experimental Group (A) Core Stability	Experimental Group (B) Vm	Difference Required	Difference Obtained
83.87	105.59		3.09	21.72
83.87		119.29	3.09	35.42
	105.59	119.29	3.09	13.7

The mean variances method was used to analyse Table 11 and determine the significant difference between the initial and final means of the treatment and control groups. The results showed that the training program led to a significant improvement in One Step Run and Kick Long Pass among players in experimental group A (core stability) and experimental group B (VM), compared to the control group. Table 12 shows that the mean variance between treatment group A (core stability) and treatment group B (VM) is 0.174, which is significantly higher than the required value of 0.102. The training programme demonstrated a significant improvement in the mean difference between treatment group A (core stability) and treatment group B (VM) compared to the control group, specifically in relation to the one-step run and long kick pass.

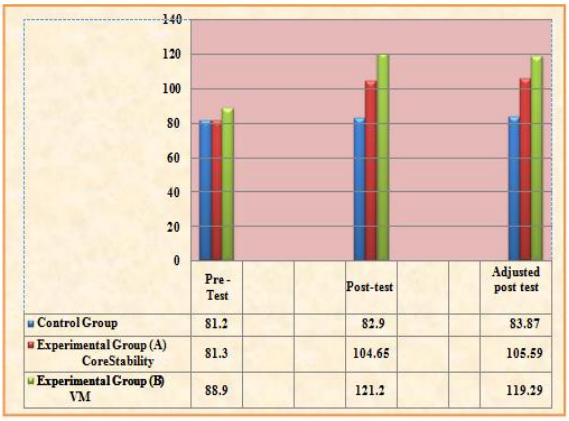

Figure 6: Comparison between Initial Means, Final Means and Adjusted Posttest Means of Treatment Group A, Treatment Group Band Control Groupon In-Situ Throw-In.

Table 11

Analysis of Covariance of the Means in One Step Run and Kick Long Pass

	Mean									
	Sample Size	Control Group	Experimental Group (A) - Core Stability	Experimental Group (B) - VM	SoV	SoS	df	MSS	F-ratio	η2
					A	0.21	2	0.11	2.17	0.07
Pre-Test	90	2.02	2.07	1.93	W	2.77	87	0.05	(Sig 0.123)	7.08%
					Total	2.98	89			
					A	1.40	2	0.70	13.76	0.325
Post test	90	2.09	2.30	2.46	W	2.91	87	0.05	(Sig 0.000)	32.56%
					Total	4.31	89			
					A	1.42	2	0.71	13.81	0.493
Adjusted Post Test	90	2.09	2.30	2.47	W	2.89	86	0.05	(Sig 0.000)	49.30%
					Corrected Total	317.36	90			
Gain Pre-Post (%)		7.20	23.20	53.70						

Table 12

Paired Means Difference on One Step Run and Kick Long Pass

Control Group	Experimental Group (A) Core Stability	Experimental Group (B) Vm	Difference Required	Difference Obtained
2.088	2.295		.102	.207
2.088		2.469	.102	.381
	2.295	2.469	.102	.174

Figure 7 presents a comparison of the Initial Means, Final Means, and Adjusted Posttest Means for Treatment Group A, Treatment Group B, and Control Group. The comparison focuses on the One Step Run and Kick Long Pass technique. The mean variances method was used to analyse Table 13 in order to determine the significant difference between the initial and final means of the treatments and control groups. The results showed that the training programme led to a significant improvement in the in-situ header performance of players in experimental group A (core stability) and experimental group B (VM) compared to the control group.

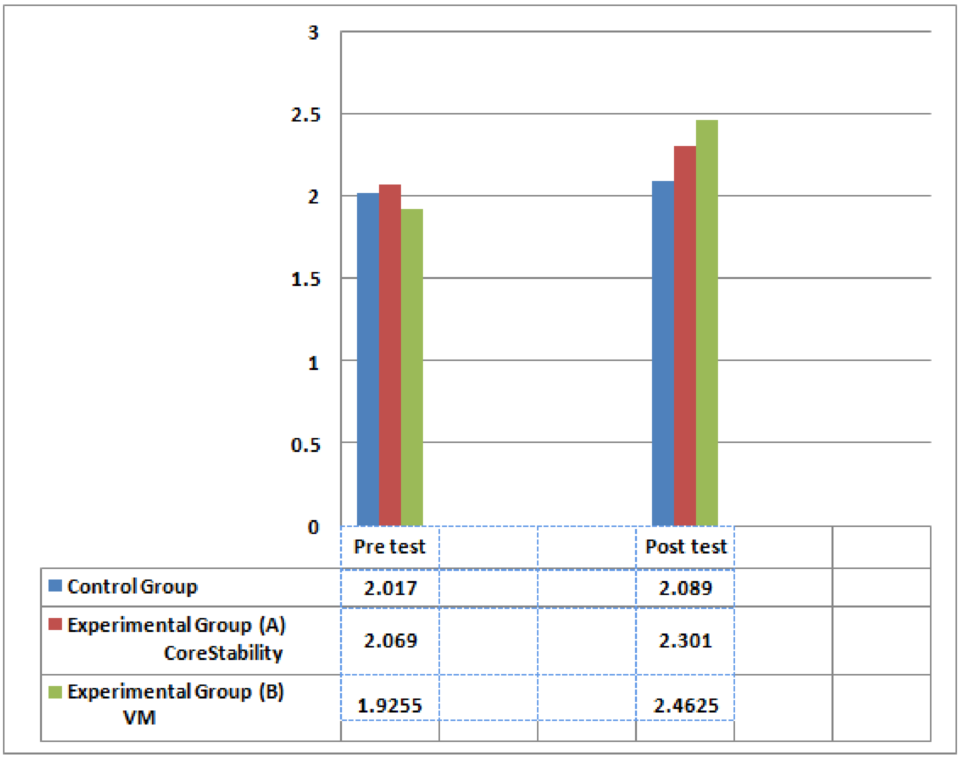

Figure 7: Comparison between Initial Means, Final Means and Adjusted Posttest Means of Treatment Group A, Treatment Group Band Control Groupon One Step Run and Kick Long Pass

Table 13

Analysis of Covariance of the Means in In-Situ Header

		Mean								
	Sample Size	Control Group	Experimental Group (A) - Core Stability	Experimental Group (B) - VM	SoV	SoS	df	MSS	F-ratio	η2
					A	30.23	2	15.12	1.79	0.059
Pre-Test	90	27.4	28.70	29.05	W	479.95	87	8.42	(Sig 0.175)	5.92%
					Total	510.18	89			
					A	381.43	2	190.72	20.34	0.416
Post test	90	27.65	33.70	31.75	W	534.50	87	9.38	(Sig 0.000)	41.64%
					Total	915.93	89			
					A	319.77	2	159.88	17.89	0.544
Adjusted Post Test	90	27.91	33.62	31.57	W	500.23	86	8.93	(Sig 0.000)	54.40%
					Corrected Total	58700.00	90			
Gain Pre-Post (%)		0.91	17.42	9.29						

Table 14 shows that the mean variance between treatment group A (core stability) and treatment group B (VM) is 2.05, which is significantly higher than the required value of 1.34. The results indicate that the training programme led to a significant improvement in the mean difference between treatment group A (core stability) and treatment group B (VM) compared to the control group, specifically in relation to the in-situ header.

Table 14

Paired Means Difference on In-Situ Header

Control Group	Experimental Group (A) Core Stability	Experimental Group (B) Vm	Difference Required	Difference Obtained
27.91	33.62		1.34	5.71*
27.91		31.57	1.34	3.66*
	33.62	31.57	1.34	2.05*

Figure 8 presents a comparison of the Initial Means, Final Means, and Adjusted Posttest Means for Treatment Group A, Treatment Group B, and Control Group. This study examines the In-Situ Header technique.
The findings indicate that core stability and VM have a significant impact on football players' balance and specific skills. The study findings indicate that core stability and VM exercises have a positive effect on athletic performance. The core stability and VM training programmes have been found to have a significant positive impact on the balance and specific skills of football players.

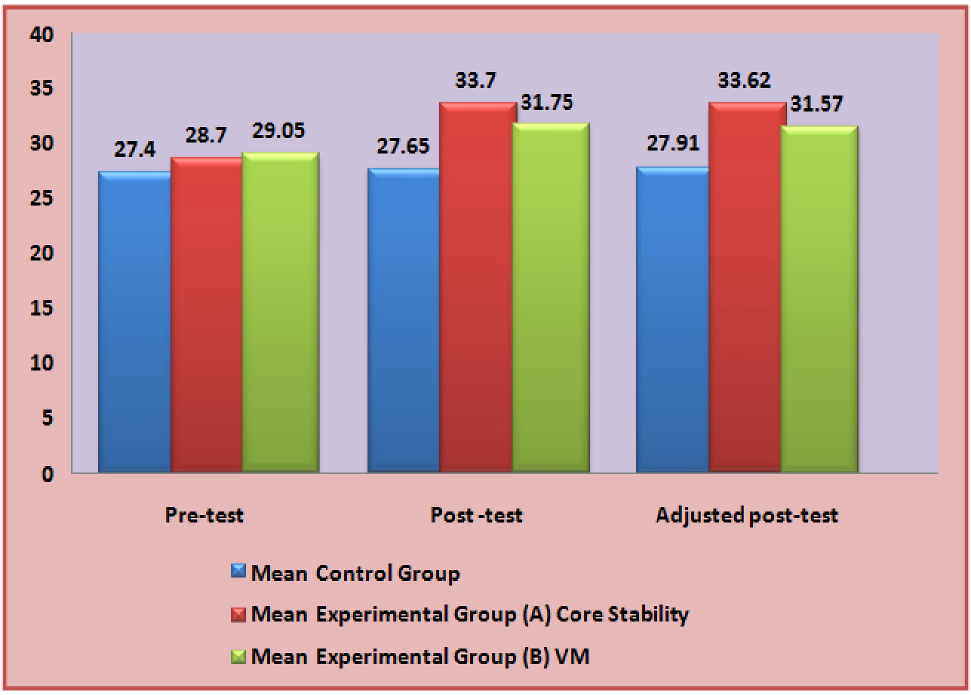

Figure 8: Comparison between Initial Means, Final Means and Adjusted Posttest Means of Treatment Group A, Treatment Group Band Control Group on In-Situ Header.

Discussion and Conclusion

The study found a strong and statistically significant correlation between core stability training and improvements in athletes' balance and specific skills. Team leaders who offer specialised training classes for core stability development can inspire athletes to maintain commitment to their goals, persevere in their efforts, view failure as a chance to learn, and achieve success in their performance. The intrinsic drive of individuals motivates them to improve their balance and acquire specific skills, thereby enhancing their performance. The results of this study align with earlier studies by esteemed scholars (Lee et al., 2017; Watanabe et al., 2014) and (Rio et al., 2017), proving that core stability training significantly boosts athletes' endurance during intense gameplay. The present study found a positive correlation between core stability training and athletes' balance and specific skills, which is consistent with previous research (Fancello et al., 2020). Additionally, the research conducted by (Wan, 2019) demonstrated a positive correlation between core stability training and athletes' balance. Athletes can enhance their performance in dynamic movements and body control by establishing a strong core foundation, as supported by previous studies (Luo et al., 2022; Saeterbakken et al., 2022). This foundation also enables athletes to maximise their potential in balance and sport-specific skills. The consistent findings highlight the importance of core stability training in enhancing athletes' overall performance (Lee et al., 2017).

In addition, the study results provide insight into the beneficial effects of Valsalva Maneuvers on athletes' balance and specific skills, which aligns with the findings of (Müller et al., 2019). Athletes employing this specialised technique exhibit exceptional skill in managing their physical exertion during demanding sporting events. Athletes achieve optimal performance by skillfully employing Valsalva Maneuvers to harmonise their body and mind. Consequently, their balance improves significantly, and they develop a set of specialised skills relevant to their respective fields.Experts in the field align the positive results with their scholarly research (Dohme et al., 2020). Their research highlights the significant impact of Valsalva Maneuvers on athletes' respiratory and cardiovascular control, resulting in improved balance and skill acquisition. Moreover, (Einarsson et al., 2020; Kim et al., 2021; Otte et al., 2020; Prieske et al., 2016) provides additional support for these findings by emphasising the common breathing difficulties that athletes face during physical games, which frequently impede their ability to achieve their goals. Through consistent practice of Valsalva Maneuvers, athletes can overcome these challenges, maintain balance, and maximise their potential in acquiring specific skills. The study conducted by (Kim et al., 2021) confirms a direct correlation between regular practice of Valsalva Maneuvers and athletes' sustained balance during gameplay. This practice also leads to a notable improvement in their specific skill set (Arslan et al., 2021; Otte et al., 2020; Prieske et al., 2016; Walter et al., 2019).

The study's findings support a positive association between core stability training, Valsalva Maneuvers, and athletes' balance and specific skills. These strong results emphasise the significance of dedicated training and specialised techniques in improving athletes' physical abilities and performance in their sports disciplines. The implications of these findings underscore the significance of incorporating core stability training and Valsalva Maneuvers into athletes' training routines to enhance their performance and achieve their full potential in sports.

Limitations and Future Recommendations

The present study emphasizes the importance of future researchers aiming for comprehensive and universally applicable findings in the field. The study examines the efficacy of core stability training and Valsalva Maneuvers in enhancing athletes' balance and specific skills. However, it is crucial to take into account additional influential factors, including physical fitness, supportive leadership, and self-efficacy. In order to enhance the comprehensiveness of the study, researchers should consider integrating questionnaire-based and interview-based research methods to collect athletes' subjective opinions and perspectives. Moreover, the study's exclusive use of data from Chinese college athletes, subject to distinct sports policies, may limit the applicability of the results. Hence, future studies should incorporate diverse athlete populations from various sports systems to gain more universally applicable insights on the correlation between core stability training, Valsalva Maneuvers, and athletes' balance and specific skills.

Data Availability

The data used to support the findings of this study are available from the author,Wenzheng Chen, upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Acknowledgement

Wenzheng Chen wrote and revised the paper, Syed Kamaruzaman Bin Syed Ali conceptionalization and proposed the method, and Hutkemri Zulnaidi validated the data and findings. This research study complied with the current laws of Malaysia.

Funding Statement

There is no any funding statement for this work.

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