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Effects of an 8-week core training program on COP-based postural sway and functional performance in male amateur soccer players

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Abstract

Background and Study Aim Core training is applied in athletic preparation to improve movement control and physical capacity. Postural stability is often assessed through balance tasks and force-platform indicators that reflect neuromuscular control. Although various training approaches are used, their relative efficiency in modifying postural sway and functional performance remains a point of practical interest. Therefore, the present study examined the effects of an eight-week core training program on change of direction, vertical jump, sprint, and center-of-pressure (COP) postural sway performance in amateur soccer players.

Material and Methods Thirty male soccer players were randomly assigned to an experimental group (n = 15) and to a control group (n = 15). The experimental group completed a core training program three times per week over a period of eight weeks, giving a total of 24 training sessions. The control group continued regular training without additional core exercises. Performance testing consisted of 30 m sprint, change of direction and vertical jump assessments conducted before and after the intervention. Postural sway was measured on a force platform under two visual conditions, eyes open and eyes closed. Each condition was tested in double leg stance for three trials of 30 seconds, and center of pressure values were recorded for anterior posterior, medial lateral and total sway.

Results After Bonferroni correction, only vertical jump performance showed significant within group improvement in the core training group (pre 41.57 ± 2.09 cm, post 42.02 ± 1.94 cm, $p < 0.001$). No significant within group changes were observed in 30 m sprint (pre 4.34 ± 0.11 s, post 4.31 ± 0.10 s, $p = 0.042$) or change of direction performance (pre 15.84 ± 0.15 s, post 15.82 ± 0.16 s, $p = 0.036$) after correcting for multiple comparisons. In between group comparisons, the core training group demonstrated greater improvement than the control group in vertical jump performance (post 42.02 ± 1.94 cm vs 40.73 ± 1.03 cm, $p = 0.035$, ES = 0.83) and showed favorable although not statistically confirmed reductions in change of direction time. No significant differences between groups were found for sprint performance.

Conclusions An eight-week core training program improved physical performance and postural stability in amateur soccer players. These findings indicate the value of incorporating core stabilization exercises to enhance neuromuscular performance among amateur soccer athletes.

Keywords: core training, postural sway, change of direction, vertical jump, sprint performance

Introduction

Core training is a common element of athletic preparation and supports the body's ability to transfer force and maintain segmental control during movement. Improved trunk stability may enhance postural alignment, reduce compensatory motion, and provide a more efficient base for sport-specific actions. As postural sway reflects the interaction of muscular control, balance, and sensory feedback, its optimization can influence the execution of sprints, jumps, and rapid changes of direction. In this context, examining how systematic core exercise affects functional performance parameters offers a practical perspective for training design. This is particularly relevant in sports that involve continuous changes in speed, direction, and body positioning.

Soccer, one of the most widely played sports globally, attracts a diverse range of male and female participants with varying levels of skill [1]. Modern soccer places higher requirements on the physical fitness and skills of athletes. In a soccer game, performance components such as running velocity, acceleration, deceleration, dribbling, passing and tackling require athletes to have good coordination and postural control skills [2].

Strength training is widely acknowledged as a method for improving athletes' physical performance [3, 4, 5]. Recently, core training (CT)

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has received increasing attention in the literature as it is considered relevant to both daily activities and sport-related performance [6]. The core is described as a muscular box defined by the abdominals, paraspinals, gluteals, the diaphragm, the pelvic floor, and the hip girdle muscles working in concert [7]. These muscles contribute to stabilizing the spine and pelvis and provide proximal stability that supports distal mobility and limb function in daily activities and sports. Core functionality also affects balance, stability, and movement efficiency. Efficient function of the core muscles supports accurate transfer and control of force to the upper and lower extremities [8].

Core stability reflects the coordinated activation of trunk muscles that maintain control of the spine and pelvis during movement [8]. Increased core stability supports physical performance through several physiological and biomechanical mechanisms, including improved force transmission, intersegmental coordination, proprioceptive feedback, and postural control [9]. By functioning as a central force-transfer hub between the upper and lower extremities, the core musculature enables more efficient energy transfer during high-speed, power-based movements such as sprinting, jumping, and change of direction [10]. From a postural control perspective, enhanced core stability reduces center-of-pressure sway and improves balance by increasing the effectiveness of proprioceptive inputs. Chaari et al. reported that greater core stability is associated with reductions in anteroposterior and mediolateral sway [11]. Taken together, these mechanisms indicate that core stability enhances trunk control and provides a biomechanical foundation that supports multiple components of athletic performance.

Many studies have reported positive effects of core training on sport performance across different disciplines, including improvements in kicking ability, balance, strength, and technical skills in karate, volleyball, and handball players [12, 14, 15]. Similar findings have been shown for distal limb performance in striking tasks, football-specific skills, soccer performance, and balance control in basketball majors [13, 16, 17, 18]. However, the relationship between core training and performance outcomes such as postural sway has not been examined in detail in the literature [19].

Analysis of research findings has shown that core training can enhance various components of athletic performance, including balance, strength expression, and the efficiency of force transfer between body segments. Researchers emphasize that trunk stability contributes to postural control and supports movement execution in actions that require rapid acceleration, deceleration, and directional change. However, the majority of the studies focus on elite athletes, with only a limited number conducted on amateur soccer players. This makes the relationship between core training, postural sway, and functional performance a relevant area for applied evaluation that warrants further targeted examination. Accordingly, the purpose of this research was to examine the effects of an eight-week core training program on change of direction (COD), vertical jump, sprint, and postural sway performance in amateur soccer players.

Materials and Methods

Participants

The study included 30 male amateur soccer players from the Ankara region. The sample size was determined using G*Power (17) based on a priori power analysis for a two-tailed t-test, assuming a medium effect size (Cohen's d = 0.50), an alpha level of 0.05, and a statistical power (1−β) of 0.80. Sample size justification: the power analysis indicated that a total of 30 participants would provide sufficient statistical power and generalizability. Accordingly, 30 players were recruited and randomly assigned to either the study group (n = 15) or the control group (n = 15).

Exclusion criteria included a history of musculoskeletal injury, surgical intervention, or lower-limb pain within the past six months; neurological, vestibular, or balance disorders; any medical condition that might affect postural control; regular use of medication influencing neuromuscular function; and missing more than 10% of training sessions during the intervention period. All participants had competed in amateur league matches for at least two years.

The control group continued regular soccer training three times per week during the eight-week intervention, with each session lasting approximately 120 minutes. Training consisted of routine technical drills, tactical gameplay, and endurance-based conditioning prescribed by team coaches. No additional core, resistance, or neuromuscular exercises were introduced. Descriptive information for the study group is presented in Table 1.

Research Design

Participants were randomly divided into two groups: the study group (n = 15) and the control group (n = 15). Random assignment was conducted using a computer-generated random number list in Microsoft Excel. A simple randomization procedure was applied, without block randomization or stratification. The randomization sequence was prepared by an independent researcher who was not involved in data collection or analysis. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes, which were opened only after baseline testing.

To minimize potential bias, all performance

Table 1. Descriptive information of the study group.

Group	Variables	N	X̄	Ss	Min	Max
Study Group	Age (years)	15	21.47	1.35	19	23
	Body weight (kg)	15	68.80	4.14	63	78
	Body height (m)	15	1.75	0.05	1.66	1.84
	Body mass index (BMI)	15	22.48	1.63	19.93	25.77
Control Group	Age (years)	15	20.13	1.50	18	23
	Body weight (kg)	15	65.13	3.22	62	73
	Body height (m)	15	1.77	0.03	1.73	1.83
	Body mass index (BMI)	15	20.71	1.14	18.51	22.39

Note. X̄ = mean; Ss = standard deviation; Min = minimum value; Max = maximum value

tests (sprint, change of direction, vertical jump, and postural sway) were administered by assessors who were blinded to group allocation. Participants were instructed not to disclose their group assignment to the evaluators. Training adherence was monitored using attendance logs completed by an independent coach at each training session. All participants completed the 8-week intervention and post-tests, representing a 100% retention rate. Training adherence was calculated as an average of 22.8 ± 1.2 out of 24 sessions (95% compliance). No adverse events or injuries were reported during the study.

The training program was implemented three times per week for eight weeks. The study group performed additional core training exercises alongside regular team practices, whereas the control group continued only routine soccer training. Measurements were conducted twice, before and after the intervention (pre-test and post-test). To familiarize participants with the testing procedures, a practice session was held prior to data collection. All tests were carried out on a grass field under similar environmental conditions and at the same time of day to reduce circadian variability. Participants were instructed to wear identical sportswear and footwear during all testing sessions.

The athletes received essential information regarding nutrition and rest practices throughout the training and testing periods. One week before the first training session, the exercises planned for the 8-week program were individually practiced and corrected until participants could perform them properly (minimizing spinal loading, maintaining correct breathing, and activating the transverse abdominis and multifidus muscles) [17, 18]. Prior to each session, athletes performed a 15-minute dynamic warm-up followed by stretching to improve flexibility, particularly in the lumbo-pelvic region, to reduce the risk of spinal injuries or lower back pain. Exercise intensity, duration, repetitions, and volume were gradually increased in line with the principle of progressive overload.

To minimize learning effects during performance testing, both groups underwent the same familiarization protocol. Following a standard warm-up, all participants performed one to two practice trials for each test (sprint, change of direction, vertical jump, and postural sway) using the same devices and instructions as in the actual procedures. These attempts were conducted solely for familiarization and were not included in the analyses. Details of the training program applied to the study group are presented in Table 2.

Exercise Descriptions and Progression

The core training program consisted of eight exercises targeting major core muscle groups. Each exercise was performed with specific durations or repetitions, increasing progressively each week as detailed in Table 2. For static exercises such as plank and side plank, participants maintained a controlled posture focusing on spinal alignment and muscle engagement throughout the prescribed duration. Dynamic exercises including crunch, back extension, Russian twist, hip raise, and bird-dog involved controlled concentric and eccentric muscle actions performed with emphasis on technique and breathing.

The tempo for dynamic movements was approximately two seconds for concentric and two seconds for eccentric phases to enhance neuromuscular control. Progression was ensured by gradually increasing duration for time-based exercises and repetitions for repetition-based movements, while maintaining exercise quality. Rest intervals were also reduced from 90 seconds in Weeks 1–4 to 60 seconds in Weeks 5–8, following the principle of progressive overload.

The progression parameters were structured according to fundamental exercise science principles to allow a gradual weekly increase in training load. During the first four weeks, durations and repetitions increased in a controlled manner to support initial neuromuscular and connective tissue adaptation. From Week 5 onward, shorter

Table 2. Training program (corrected format)

Exercises	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
1-Plank (s)	25×2	25×2	30×2	30×2	40×2	40×2	50×2	50×2
2-Side plank (right) (s)	25×2	25×2	30×2	30×2	40×2	40×2	50×2	50×2
3-Side plank (left) (s)	25×2	25×2	30×2	30×2	40×2	40×2	50×2	50×2
4-Crunch (rep)	20×2	20×2	25×2	25×2	30×2	30×2	35×2	40×2
5-Back extension (rep)	20×2	20×2	25×2	25×2	30×2	30×2	35×2	40×2
6-Russian twist (rep)	25×2	25×2	30×2	30×2	35×2	35×2	40×2	40×2
7-Hip raise (rep)	20×2	20×2	25×2	25×2	30×2	30×2	35×2	35×2
8-Bird dog (s)	25×2	25×2	30×2	30×2	35×2	35×2	40×2	40×2
Rest between sets (s)	90	90	90	90	60	60	60	60

rest intervals were introduced to increase metabolic stress, muscular endurance, and neuromuscular demand. Previous studies indicate that reducing rest duration elevates metabolic load, accelerates local fatigue, and increases demands on stabilizing musculature.

Data Collection Tools: Body height was measured using a wall-mounted Holtain stadiometer (England) with 1 mm accuracy, and body weight was measured with a Tanita BC480 digital scale (Japan). Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters (kg/m^2), following the World Health Organization (WHO) standard.

30 m Sprint Test: Sprint times were recorded using infrared photocell gates (Witty-Microgate, Italy). Athletes started each sprint 30 cm behind the starting line and were instructed to run through the timing gates at maximum speed. Each athlete completed two attempts, and the best time was retained for analysis. A 3-minute rest interval was provided between repetitions.

Illinois Change of Direction Test: A test track measuring 5 m in width and 10 m in length was set up on a grass soccer field, with three cones placed along the mid-section at 3.3 m intervals. Change of direction performance was measured using infrared photocell gates. Athletes started 1 m behind the starting line and were instructed to complete the track at maximum effort. Each participant performed two attempts, and the best time was recorded in seconds.

Vertical Jump Test: Vertical jump performance was assessed using two OptoJump devices (Microgate, Italy) placed opposite each other. Previous studies have shown that the OptoJump photoelectric system provides highly reliable estimates of jump height (ICC = 0.99, 95% CI 0.97–0.99; $p < 0.001$) [20, 21]. Participants performed the test with their hands on their hips, remaining still until prompted by a verbal signal. They were instructed to jump as quickly and as high as possible, minimizing the transition between the eccentric and concentric phases. The depth of the countermovement was self-selected, and participants were advised to avoid movement during the flight phase [22]. Attempts were deemed invalid if athletes failed to maintain hands on hips at take-off or if they raised, spread, or pulled their knees or feet upward or outward. Each participant completed three attempts with a one-minute rest interval between trials.

Postural Sway Measurement: Postural sway was assessed using a Kistler® force platform (Switzerland). A measurement protocol was created in the *Body Sway* module, and sway values were obtained during a static balance test. Measurements were performed in a double-leg stance with eyes open and eyes closed. Participants completed 2–3 minutes of familiarization trials prior to testing to reduce learning effects. After a five-minute warm-up, athletes were instructed to focus on a fixed point located 1 m in front of them, remain as still as possible, and keep their arms relaxed at their sides. Standing at the center of the force platform, participants positioned their feet in the anterior–posterior (A–P) direction along the Y-axis and medial–lateral (M–L) direction along the X-axis, with toes pointing forward (+Y). The test began following a verbal countdown (3–2–1). Each participant performed three 30-second trials with eyes open and three 30-second trials with eyes closed. A two-minute rest interval was provided between trials to minimize fatigue-related effects. The reliability and validity of Kistler® force platforms for postural sway assessment have been demonstrated in previous studies, supporting their suitability for balance analysis.

Statistical Analysis

Data management and missing data: Prior to hypothesis testing, all datasets were screened for outliers, input errors, and missing records. Values exceeding ±3 SD from the group mean were crosschecked against original measurement files. Missing or invalid observations related to primary outcome measures were handled using complete-case analysis; participants with missing data for a specific variable were excluded from the corresponding comparison. No imputation procedures were applied.

Analytical procedures: Data analysis was performed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro–Wilk test, supported by skewness and kurtosis values. Variables with $p > 0.05$ and skewness/kurtosis values within ±1.0 were considered normally distributed and were evaluated using parametric statistics. When normality assumptions were violated, non-parametric alternatives were used. Within-group comparisons were conducted using paired t-tests or the Wilcoxon signed-rank test. Between-group differences were assessed using independent t-tests or the Mann–Whitney U test. Effect sizes were calculated to determine the magnitude of differences. For parametric outcomes, Cohen's d values of 0.2, 0.5, and 0.8 represented small, medium, and large effects. For non-parametric outcomes, effect size r was calculated as $r = Z / \sqrt{N}$, with thresholds of 0.1, 0.3, and 0.5 indicating small, medium, and large effects. Statistical significance was set at $p < 0.05$, and Bonferroni adjustments were applied to control for multiple comparisons.

Results

Pre- and post-test values for change of direction, 30 m sprint, and vertical jump performance in both groups are presented in Table 3. The table includes mean scores, standard deviations, effect sizes, p-values, and Bonferroni-adjusted significance outcomes for each variable.

Table 3 shows that the study group demonstrated improvements in change of direction ($p = .036$, ES = 0.13) and 30-m sprint performance ($p = .042$, ES = 0.29), as well as a statistically significant increase in vertical jump height ($p < .001$, ES = 0.22). After Bonferroni adjustment ($\alpha = 0.0083$), only the improvement in vertical jump performance remained statistically significant. No significant changes were observed in the control group. These results indicate that the eight-week core training program had the greatest effect on vertical jump performance, whereas changes in sprint and change of direction ability were small and not statistically meaningful after correction.

Postural sway outcomes for anterior–posterior, medial–lateral, and total sway under eyes-open and eyes-closed conditions are presented in Table 4. The table summarizes pre- and post-intervention values, Wilcoxon test statistics, p-values, effect sizes, and Bonferroni-adjusted significance results for the experimental group.

Table 4 shows that in the experimental group, statistically significant and large reductions were observed in postural sway under eyes-closed conditions, including anterior–posterior sway ($p = .001$, $r = 0.84$), medial–lateral sway ($p = .001$, $r = 0.87$), and total sway ($p = .003$, $r = 0.76$). These improvements

Table 3. Paired t-test results for pre- and post-test measurements of COD, 30 m sprint, and vertical jump in study and control groups.

Variables	Group	Measurement	X̄	Ss	t	p	ES	Bonferroni α	Significant
COD (s)	Study	pre-test	15.84	0.15	2.320	.036	0.129	0.0083	No
		post-test	15.82	0.16					
	Control	pre-test	15.87	0.16	-1.468	.164	0.063	0.0083	No
		post-test	15.88	0.16					
30 m sprint (s)	Study	pre-test	4.34	0.11	2.244	.042	0.285	0.0083	No
		post-test	4.31	0.10					
	Control	pre-test	4.37	0.12	-1.164	.264	0.087	0.0083	No
		post-test	4.38	0.11					
Vertical jump (cm)	Study	pre-test	41.57	2.09	-2.271	.000	0.22	0.0083	Yes
		post-test	42.02	1.94					
	Control	pre-test	40.88	1.08	1.643	.123	0.142	0.0083	No
		post-test	40.73	1.03					

Table 4. Pre-test and post-test postural sway Wilcoxon test results of the experimental group

Variables (mm)	Measurement	X̄	Ss	Z	p	ES (r)	Bonferroni α	Significant
Anterior-Posterior Sway (mm) (eyes closed, double-leg stance)	pre-test	132.56	49.55	-3.237	.001	0.84	0.0083	Yes
	post-test	87.84	28.66					
Medial-Lateral Sway (mm) (eyes closed, double-leg stance)	pre-test	56.18	17.13	-3.351	.001	0.87	0.0083	Yes
	post-test	42.41	12.59					
Total Sway (mm) (eyes closed, double-leg stance)	pre-test	290.24	84.06	-2.953	.003	0.76	0.0083	Yes
	post-test	210.51	85.10					
Anterior-Posterior Sway (mm) (eyes open, double-leg stance)	pre-test	124.56	61.45	-2.499	.012	0.65	0.0083	No
	post-test	112.14	65.85					
Medial-Lateral Sway (mm) (eyes open, double-leg stance)	pre-test	51.85	21.71	-3.124	.002	0.81	0.0083	Yes
	post-test	41.70	21.23					
Total Sway (mm) (eyes open, double-leg stance)	pre-test	236.74	84.35	-2.045	.041	0.53	0.0083	No
	post-test	216.89	85.60					

Note: Effect size calculated as $r = Z / \sqrt{N}$.

remained significant after Bonferroni adjustment (α = 0.0083). Under eyes-open conditions, a significant decrease was found only in medial–lateral sway (p = .002, r = 0.81), while changes in anterior–posterior sway (p = .012, r = 0.65) and total sway (p = .041, r = 0.53) did not meet the corrected significance threshold. These findings indicate that the training program produced the greatest postural stability improvements when visual input was removed, suggesting enhanced proprioceptive control and neuromuscular regulation.

Postural sway outcomes for the control group under eyes-open and eyes-closed conditions are presented in Table 5. The table includes pre- and post-test values, Wilcoxon Z statistics, p-values, effect sizes, and Bonferroni-adjusted significance results, allowing comparison with changes observed in the experimental group.

Table 5 shows that no statistically significant differences were found between pre- and post-test postural sway values in the control group. With eyes closed, anterior–posterior (p = .320, r = 0.26), medial–lateral (p = .112, r = 0.41), and total sway (p = .307, r = 0.26) scores did not change meaningfully. Similarly, under eyes-open conditions, anterior–posterior (p = .125, r = 0.40), medial–lateral (p = .256, r = 0.29), and total sway (p = .233, r = 0.31) outcomes showed no significant differences. After Bonferroni adjustment (α = 0.0083), none of the results reached statistical significance. These findings indicate that regular soccer training performed by the control group did not produce measurable improvements in balance or postural sway.

Between-group comparisons of change of direction, 30 m sprint, and vertical jump performance are summarized in Table 6. The table presents independent t-test results for pre- and post-intervention measurements, including mean values, standard deviations, p-values, and effect sizes for both the experimental and control groups.

Table 6 shows that only post-test vertical jump performance differed significantly between the experimental and control groups (p = .035, ES = 0.83). No significant between-group differences were observed in COD (pre-test p = .540, ES = 0.19; post-test p = .317, ES = 0.38) or 30-m sprint performance (pre-test p = .414, ES = 0.26; post-test p = .115, ES = 0.67). These results indicate that the eight-week core training program led to greater improvements in vertical jump height compared with the control group, whereas changes in COD and sprint performance were small and not statistically meaningful.

Between-group comparisons of postural sway values under eyes-open and eyes-closed conditions are presented in Table 7. The table reports Mann–Whitney U test results for pre- and post-test measurements, including mean ranks, U statistics, p-values, and significance after Bonferroni adjustment for the experimental and control groups.

Table 7 shows that no statistically significant differences were observed between the experimental and control groups in any postural sway variable under eyes-closed or eyes-open conditions after Bonferroni adjustment (α = 0.0042). Although

Table 5. Pre-test and post-test postural sway Wilcoxon test results of the control group

Variables (mm)	Measurement	X̄	Ss	Z	p	ES (r)	Bonferroni α	Significant
Anterior-Posterior Sway (eyes closed, double-leg stance)	pre-test	122.60	48.49	-.994	.320	0.26	0.0083	No
	post-test	123.41	49.17					
Medial-Lateral Sway (eyes closed, double-leg stance)	pre-test	68.67	47.43	-1.590	.112	0.41	0.0083	No
	post-test	67.04	40.04					
Total Sway (eyes closed, double-leg stance)	pre-test	288.56	87.71	-1.023	.307	0.26	0.0083	No
	post-test	295.21	95.48					
Anterior-Posterior Sway (eyes open, double-leg stance)	pre-test	165.33	89.32	-1.533	.125	0.40	0.0083	No
	post-test	165.28	88.91					
Medial–Lateral Sway (eyes open, double-leg stance)	pre-test	76.09	47.11	-1.136	.256	0.29	0.0083	No
	post-test	71.94	37.41					
Total Sway (eyes open, double-leg stance)	pre-test	282.70	91.37	-1.193	.233	0.31	0.0083	No
	post-test	284.25	90.73					

Note: Effect size calculated as r = Z / √N.

Table 6. Independent t-test results for pre-test and post-test measurements of COD, 30 m sprint, and vertical jump

Variables	Measurement	Study Group (X̄ ± Ss)	Control Group (X̄ ± Ss)	t	p	ES
COD (s)	Pre-test	15.84 ± 0.15	15.87 ± 0.16	0.620	.540	0.19
	Post-test	15.82 ± 0.16	15.88 ± 0.16	0.101	.317	0.38
30 m Sprint (s)	Pre-test	4.34 ± 0.11	4.37 ± 0.12	-0.829	.414	0.26
	Post-test	4.31 ± 0.10	4.38 ± 0.11	-0.163	.115	0.67
Vertical Jump (cm)	Pre-test	41.57 ± 2.09	40.88 ± 1.08	1.132	.270	0.42
	Post-test	42.02 ± 1.94	40.73 ± 1.03	2.257	.035	0.83

Table 7. Mann–Whitney U test results for pre-test and post-test postural sway measurements in the experimental and control groups

Variables (mm)	Measurement	Study Group (X̄ ± Ss)	Control Group (X̄ ± Ss)	U	p	ES (r)	Bonferroni α	Significant
Anterior–Posterior sway (eyes closed, double-leg stance)	Pre-test	132.56 ± 49.55	122.60 ± 48.49	93.00	.41	0.14	0.0042	No
	Post-test	87.84 ± 28.66	123.41 ± 49.17	64.00	.04	0.36	0.0042	No
Medial–Lateral sway (eyes closed, double-leg stance)	Pre-test	56.18 ± 17.13	68.67 ± 47.43	110.00	.91	0.02	0.0042	No
	Post-test	42.41 ± 12.59	67.04 ± 40.04	65.00	.04	0.36	0.0042	No
Total sway (eyes closed, double-leg stance)	Pre-test	290.24 ± 84.06	288.56 ± 87.71	111.50	.96	0.00	0.0042	No
	Post-test	210.51 ± 85.10	295.21 ± 95.48	62.50	.03	0.37	0.0042	No
Anterior–Posterior sway (eyes open, double-leg stance)	Pre-test	124.56 ± 64.45	165.33 ± 89.32	94.00	.44	0.14	0.0042	No
	Post-test	112.14 ± 65.85	165.28 ± 88.91	62.00	.03	0.38	0.0042	No
Medial–Lateral sway (eyes open, double-leg stance)	Pre-test	51.85 ± 21.71	76.09 ± 47.11	79.00	.16	0.25	0.0042	No
	Post-test	41.70 ± 21.33	71.94 ± 37.41	54.50	.01	0.44	0.0042	No
Total sway (eyes open, double-leg stance)	Pre-test	236.74 ± 84.35	282.70 ± 91.37	78.00	.15	0.26	0.0042	No
	Post-test	216.89 ± 85.60	284.25 ± 90.73	61.50	.03	0.38	0.0042	No

Note: Effect size calculated as r = Z / √N.

several post-test outcomes demonstrated small-to-moderate effect sizes (r = 0.14–0.44), none exceeded the corrected significance threshold. Pre-test values likewise showed no meaningful differences between groups, indicating comparable baseline balance characteristics prior to the intervention. These findings suggest that, despite a trend toward lower sway magnitudes in the experimental group, between-group differences did not reach statistical significance.

Discussion

The present study aimed to examine whether an eight-week core training program would influence change of direction, 30-m sprint, vertical jump performance, and postural sway in soccer players. The results showed that vertical jump performance improved in the training group and remained statistically significant after Bonferroni adjustment. Improvements in change of direction and sprint times were small and did not reach statistical significance after correction. Postural sway measures with eyes closed demonstrated clear reductions in sway amplitude within the training group, while between-group comparisons did not reveal statistically meaningful differences. Together, these findings indicate that the core-centered intervention was most effective in enhancing jump performance and internal stability control, whereas changes in sprint and directional movement ability were limited.

This study contributes to the existing body of research in three ways. First, it examines the effects of core training on force-platform–based measurements of postural sway in soccer players using controlled experimental design. Second, it evaluates change of direction, sprint time, vertical jump, and balance variables within the same investigation, allowing these outcomes to be interpreted in relation to one another. Third, it focuses on athletes competing at a non-elite level, which extends current findings that have predominantly been drawn from research involving higher-performance groups.

Postural sway measurements indicated that core training was associated with improved balance control. The reduction in anterior–posterior and medial–lateral sway, particularly under eyes-closed conditions, may reflect positive changes in proprioceptive regulation. These outcomes align with reports suggesting that exercises targeting core stability can influence postural balance [23, 24, 25, 26, 27].

The observed results may be considered within the context of motor control concepts. From a dynamic systems viewpoint, core-related adaptations could contribute to more coordinated segmental interactions, which may in turn relate to changes in sprint, jump, and change-of-direction performance. Reductions in sway also suggest more stable integration of feedforward and feedback mechanisms within postural regulation frameworks. Such adaptations may facilitate proximal-to-distal force transfer during movement execution, allowing athletes to perform lower-limb actions with a more stable trunk position. In this regard, core training may influence both local stabilization of the trunk and broader control processes relevant to fast movement actions in soccer.

When vertical jump performance was examined, core training was associated with a measurable improvement in this variable. One possible explanation is the involvement of core musculature in the transfer and regulation of force across the upper and lower extremities. Previous research has reported similar outcomes. Doğan and Mendeş [28] observed improvements in vertical jump following an eight-week core program in soccer players, and another study reported increased jump performance in 11–13-year-old players after a ten-week intervention [29]. Although preliminary within-group analyses indicated changes in sprint and change-of-direction performance, these effects were not maintained after Bonferroni adjustment. For this reason, interpretations of sprint and COD outcomes should rely primarily on between-group comparisons. In this regard, the core training group showed more notable changes than the control group, especially in vertical jump height and directional-change outcomes. Taken together, these results suggest that core training alone may not produce pronounced improvements in sprint or COD ability, but may contribute to neuromuscular features relevant to speed-power tasks when integrated with complementary training approaches.

Core training being effective in non-elite soccer players addresses an area that is less represented in previous research. While many studies have concentrated on elite populations [16], the present work examined performance outcomes in amateur players. These findings may be useful for planning training approaches for developing athletes and for structuring programs that target balance, jump capacity, and related neuromuscular components.

Limitations

This study has several limitations. The sample size was relatively small, which limits generalizability and reduces the ability to detect small differences between groups. Although the intervention lasted eight weeks, this duration may be insufficient for observing longer-term neuromuscular adaptations to core training. In addition, several improvements did not remain statistically significant following Bonferroni adjustment, which indicates that the stability of some outcomes should be interpreted cautiously. Future studies may benefit from larger samples, extended intervention periods, and the inclusion of additional neuromuscular measures to examine long-term effects more comprehensively. The characteristics of the sample also impose restrictions. The study involved only male amateur soccer players, meaning that findings may not be directly transferable to female players, different age groups, or athletes from other performance levels. The use of multiple performance variables introduces the potential for both Type I and Type II error. While Bonferroni correction helped reduce the likelihood of Type I error, it simultaneously increased the probability of Type II error, resulting in the possibility that real effects were not detected. For this reason, the outcomes should be interpreted with consideration of the multiple comparison structure used.

Practical Applications

The findings of this study suggest that core training may be considered as a component of physical preparation in soccer, particularly when the goal is to improve jump-related outputs and postural stability. Coaches and practitioners may incorporate structured core exercises into regular training cycles to support trunk control, improve balance regulation under reduced visual feedback, and assist in preparing athletes for actions requiring controlled force transfer. The absence of marked changes in sprint and change-of-direction outcomes indicates that core training may function more effectively when combined with other performance-oriented methods such as plyometrics, short-acceleration drills, and repeated COD practice. Integrating core programs with speed–power training could provide a more complete stimulus for performance development. When planning training loads, practitioners may also consider adjusting intervention duration and progression to target both stability and sport-specific locomotor demands.

Conclusions

The outcomes of this study indicate that core training can be integrated into physical preparation to support postural stability and power-related actions in soccer. These adaptations appear most evident in balance control under reduced visual input and in tasks requiring vertical force production. Improvements in other performance domains were modest, which suggests that core training acts as a complementary rather than a primary performance driver. Taken together, the findings position core training as one element within a broader conditioning framework rather than a stand-alone method for speed or directional movement enhancement. Its value may be realized most effectively when combined with sport-specific drills, power development, and movement-based training progressions. Continued investigation may clarify how the timing, duration, and integration of core work shape its contribution to athlete development over longer cycles.

Consent to Participate

Written informed consent was obtained from all participants prior to data collection.

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Conflict of Interest

The authors declare no conflict of interest.

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