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POSTURAL BALANCE IN FEMALE SOCCER PLAYERS: DOES PLAYING POSITION IMPACT PERFORMANCE?

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Abstract: *This cross-sectional observational study assesses balance and proprioception in 49 female soccer players using Sensbalance Miniboard. Static and dynamic balance (lateral, vertical) and proprioception were evaluated. Descriptive results suggest positional variations: midfielders show balanced static and lateral dynamic stability with low proprioception, forwards stable balance with notable lateral deviations, defenders low static balance with moderate dynamic control and proprioception, and goalkeepers superior balance with high proprioceptive performance. However, the ANOVA findings indicate no statistically significant effect of playing position on balance ($p > 0.05$). In practical, real-world contexts, these findings highlight the importance of implementing position-specific training strategies to improve stability, reduce injury risk, and enhance overall performance.*

Keywords: *balance; proprioception; postural stability; female soccer; women's football.*

1. Introduction

Postural balance is a fundamental component of athletic performance [4], influencing both the execution of sport-specific skills and the prevention of injuries. In football, where rapid directional changes and intense physical interactions are common, maintaining stability in dynamic situations depends on optimal balance and proprioception. Women's soccer is a relatively new sport, like men's, involving endurance, repetitive movements, and a high risk of injury [16]. Despite its importance, research focusing on the interplay between playing position and postural control in women's soccer remains scarce [5, 6, 8]. This study seeks to address this gap by investigating whether the specific demands of different playing positions affect balance performance. Playing positions in soccer

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are associated with distinct physical and tactical requirements, potentially leading to variations in neuromuscular control and postural stability [7]. A thorough examination of how positional roles impact balance performance in female soccer players offers valuable insights into developing position-specific training programs aimed at enhancing stability, improving neuromuscular coordination, and reducing injury risks. Understanding the unique demands of each positional role enables coaches and sports scientists to devise targeted interventions that optimize postural control, facilitate superior athletic performance, and contribute significantly to overall athletic health and development.

2. Objectives

This study provides a comprehensive analysis of the relationship between playing position and balance performance in female soccer players. It systematically assesses static and dynamic balance, alongside proprioceptive capabilities, to discern potential positional differences in postural stability. Furthermore, the investigation aims to determine if playing position significantly impacts balance outcomes. By advancing the understanding of postural control mechanisms specific to women's soccer, the findings offer original contributions to the development of targeted, evidence-based training regimens.

3. Material and Methods

Balance and proprioception were assessed using the Sensbalance MiniBoard and Software [10] at the Human Performance Research Department, Pitești University Center, part of National University of Science and Technology Politehnica Bucharest, Romania. The research took place from April 30 to May 6, 2024.

A total of 49 female soccer players from ACS Champions Football Club FC Argeș participated in the study, with both parental consent and institutional approval obtained in accordance with the Declaration of Helsinki. The players had a mean age of 13.73 years, an average height of 160.43 cm, an average weight of 51.39 kg, and a mean BMI of 19.85 kg/m².

Standardized tests, each performed twice, included the Bipodal Static Balance Test for postural sway and neuromuscular control, the Bipodal Dynamic Balance Test for lateral and vertical stability, and the Proprioception Test for body awareness, reaction time, and alignment.

Data analysis was performed using DATAtab, an online statistics calculator [1]. The shortest reaction time was considered for statistical processing. Descriptive statistics and repeated-measures ANOVA were applied, with significance set at $p < 0.05$.

3. Results and Discussions

3.1. Static balance

Descriptive Statistics

A detailed analysis of static balance (SB) for each playing position (PP), based on the data presented (Table 1), reveals the following:

Forwards (FWD) demonstrate a performance level of 78.57%, with small average deviations in the forward (1.2°) and backward (-1.14°) directions. However, they exhibit larger average lateral deviations to the left (-1.5°) and

right (1.62°), indicating slight instability in lateral movements.

Midfielders (MID) achieve a performance level of 77.94%, with similar average deviations in the forward (1.2°) and backward (-1.36°) directions. They perform better in maintaining balance to the right (1.27°) but exhibit larger average deviations to the left (-1.54°).

Defenders (DEF) record a performance level of 76.14%, with greater average deviations in the forward (1.36°) and backward (-1.42°) directions. Their lateral average deviations to the left (-1.51°) and right (1.42°) suggest a higher degree of instability compared to the other positions.

Goalkeepers (GK) demonstrate the highest performance level of 82.67%, with minimal average deviations in all directions: front (1.17°), backward (-1.1°), left (-1.05°), and right (0.71°), indicating exceptional postural control.

SB per PP Table 1

Indicators/PP	FWD	MID	DEF	GK
Performance [%]	78.57	77.94	76.14	82.67
Front Avg. Dev [°]	1.2	1.2	1.36	1.17
Back Avg. Dev [°]	-1.14	-1.36	-1.42	-1.1
Left Avg. Dev [°]	-1.5	-1.54	-1.51	-1.05
Right Avg. Dev [°]	1.62	1.27	1.42	0.71

Repeated Measures ANOVA

The results of the repeated measures ANOVA (Table 2) indicate significant differences among the analyzed indicators ($p<.001p < .001$), with very large effect sizes ($\eta^2 = 0.98$; $\eta^2 = 0.99$). Conversely, playing position (PP) showed no statistically significant differences ($p=.677p = .677$), with negligible effect sizes ($\eta^2 = 0$; $\eta^2 = 0.03$).

Table 2

ANOVA SB

Variables	df	p	η^2	η^2_p
Indicators	4	<.001	0.98	0.99
PP	3	.677	0	0.03

3.2. Lateral Dynamic Balance

Descriptive Statistics

The performance of lateral dynamic balance (LDB) according to playing position (Table 3), the lateral dynamic balance of female football players varies, impacting stability and the ability to react quickly to directional changes and physical duels.

Forwards (74.71%) show the lowest balance performance, likely due to frequent accelerations and directional changes. Their weight distribution score (43 front, 31.57 back) suggests an aggressive stance with great lateral average deviations (left: -4.4°, right: 4.28°).

Table 3

LDB per PP

Indicators/PP	FWD	MID	DEF	GK
Performance (%]	74.71	76.67	76.86	84.33
Left, interior	43	36.11	39.57	43
Right, interior	31.57	40.44	37.86	40.33
Front Avg. Dev [°]	1.53	1.53	1.5	1.3
Back Avg. Dev [°]	-1.38	-1.57	1.64	-1.2
Left Avg. Dev [°]	-4.4	-4.05	-4.17	-4.31
Right Avg. Dev [°]	4.28	4.08	4.26	3.9

Midfielders achieved a balance performance of 76.67%, with weight distribution values of 36.11 (left interior) and 40.44 (right interior). Their postural deviations were moderate, with a forward deviation of 1.53° and a backward deviation of -1.57°. Laterally, they exhibited deviations of -4.05° (left) and 4.08° (right).

Defenders achieved a balance performance of 76.86%, with weight distribution values of 39.57 (left interior) and 37.86 (right interior). Their postural deviations included a forward deviation of 1.5° and the highest backward deviation among all positions at -1.64°. Laterally, they exhibited deviations of -4.17° (left) and 4.26° (right). This stability likely reflects their role in maintaining defensive structure, responding to opponent movements, and executing quick lateral adjustments.

Goalkeepers achieved the highest balance performance at 84.33%, with weight distribution values of 43 (left interior) and 40.33 (right interior). Their postural deviations were the smallest among all positions, with a forward deviation of 1.3° and a backward deviation of -1.2°. Laterally, they exhibited deviations of -4.31° (left) and 3.9° (right). This high level of stability is essential for maintaining balance during rapid positional adjustments, explosive movements, and reactive saves.

Repeated Measures ANOVA

The results of the analysis of variance (Table 4) indicate a significant effect for the analyzed indicators ($p < .001$), with a large effect size ($\eta^2 = 0.89$, $\eta^2_p = 0.91$). However, no significant differences were observed between playing positions ($p = .87$), with a negligible effect size ($\eta^2 = 0$, $\eta^2_p = 0.01$), suggesting that playing position does not substantially influence lateral dynamic balance.

ANOVA LDB Table 4

Variables	df	p	η^2	η^2_p
Indicators	6	<.001	0.89	0.91
PP	3	.87	0	0.01

3.3. Vertical Dynamic Balance

Descriptive Statistics

The data presented (Table 5) reflect the vertical dynamic balance (VDB) performance of female football players according playing role.

Forwards exhibited a vertical dynamic balance performance of 66%, with a weight distribution of 30.71 (left interior) and 34.71 (right interior). Their postural deviations included a forward deviation of 4.65° and a backward deviation of -4.1°, indicating a tendency toward a forward-leaning posture. Laterally, they demonstrated deviations of -2.08° (left) and 1.8° (right), reflecting moderate lateral instability, which may be linked to the frequent accelerations and directional changes required in their role.

Midfielders exhibited the lowest vertical dynamic balance performance at 65.56%, with a weight distribution of 35.44 (left interior) and 30 (right interior). Their postural deviations included a forward deviation of 4.43° and a backward deviation of -4.13°, indicating a slight backward inclination. Laterally, they demonstrated deviations of -2.16° (left) and 1.91° (right), suggesting moderate lateral instability.

Defenders achieved a vertical dynamic balance performance of 71.67%, with a weight distribution of 36.71 (left interior) and 34.95 (right interior), indicating a more evenly distributed stance compared to other positions. Their postural deviations included a forward deviation of 4.46° and a backward deviation of -3.94°, reflecting a relatively stable posture with a slight forward inclination. Laterally, they exhibited deviations of -1.82° (left) and 1.85° (right), which were smaller than those observed in forwards and midfielders.

Goalkeepers demonstrated the highest vertical dynamic balance performance at 85.67%, indicating superior postural control. Their weight distribution of 36.33 (left interior) and 49.33 (right interior) suggests a greater reliance on the right side. They exhibited the smallest forward (3.84°) and backward (-2.98°) average deviations among all positions, reflecting a well-balanced and controlled posture. Laterally, they showed deviations of -1.89° (left) and 1.04° (right), the lowest among all playing positions, reinforcing their ability to maintain stability. This balance profile is essential for goalkeepers, as it allows for quick positional adjustments, explosive movements, and precise body control during reactive saves.

VDB per PP Table 2

Indicators/PP	FWD	MID	DEF	GK
Performance (%]	66	65.56	71.67	85.67
Left, interior	30.71	35.44	36.71	36.33
Right, interior	34.71	30	34.95	49.33
Front Avg. Dev [°]	4.65	4.43	4.46	3.84
Back Avg. Dev [°]	-4.1	-4.13	-3.94	-2.98
Left Avg. Dev [°]	-2.08	-2.16	-1.82	-1.89
Right Avg. Dev [°]	1.8	1.91	1.85	1.04

Repeated Measures ANOVA

The ANOVA results for vertical dynamic balance (Table 6) revealed a significant effect for the analyzed indicators ($p < .001$), with a large effect size ($\eta^2 = 0.9$, $\eta^2_p = 0.93$). However, no significant differences were observed between

playing positions (p = .141), with a negligible effect size ($\eta^2 = 0$, $\eta^2_p = 0.11$).

Table 6

ANOVA VDB

Variables	df	p	η^2	η^2_p
Indicators	6	<.001	0.9	0.93
PP	3	.141	0	0.11

These results suggest that while vertical dynamic balance varies significantly across the measured indicators, playing position does not have a substantial impact on vertical dynamic balance performance.

3.4. Proprioception

Descriptive Statistics

The SensaMove balance platform results indicate positional differences in proprioception (PRP) and postural control in female football players (Table 7).

PRP per PP Table 3

Indicators/PP	FWD	MID	DEF	GK
Performance [%]	70.71	66.11	68.86	80
Front Avg. Dev [°]	1.89	1.39	1.98	1.22
Back Avg. Dev [°]	-1	-1.77	-1.2	-0.83
Left Avg. Dev [°]	-2.12	-2.03	-1.62	-1.15
Right Avg. Dev [°]	1.53	1.43	1.37	0.87

Forwards achieved a proprioception performance of 70.71%. Their postural deviations included a front average deviation of 1.89° and a backward average deviation of -1°, indicating a slight forward-leaning stance. Laterally, they exhibited deviations of -2.12° (left) and 1.53° (right), showing moderate asymmetry in balance control.

Midfielders achieved the lowest proprioception performance at 66.11%. Their postural deviations included a front average deviation of 1.39° and a backward average deviation of -1.77°, indicating a greater backward shift. Laterally, they exhibited average deviations of -2.03° (left) and 1.43° (right), reflecting moderate asymmetry.

Defenders achieved a proprioception performance of 68.86%, higher than midfielders but lower than forwards and goalkeepers. Their postural deviations included a front average deviation of 1.98° and a backward deviation of -1.2°, indicating a slightly forward-leaning posture. Laterally, they exhibited average deviations of -1.62° (left) and 1.37° (right), showing the lowest lateral asymmetry among outfield players.

Goalkeepers achieved the highest proprioception performance at 80%, indicating superior postural control compared to other positions. Their postural deviations included a front average deviation of 1.22° and a backward average deviation of -0.83°, reflecting the most balanced anterior-posterior control. Laterally, they exhibited the smallest deviations among all positions, with -1.15° (left) and 0.87° (right), suggesting minimal asymmetry.

Repeated Measures ANOVA

The results of the repeated measures ANOVA (Table 8) The repeated-measures

ANOVA for proprioception (PRP) revealed a significant effect for the analyzed indicators ($p < .001$), with a large effect size ($\eta^2 = 0.96$, $\eta^2_p = 0.97$).

However, no significant differences were observed between playing positions ($p = .282$), with a negligible effect size ($\eta^2 = 0$, $\eta^2_p = 0.08$).

These results suggest that while proprioceptive performance varies significantly across the measured indicators, playing position does not have a substantial impact on proprioceptive control.

Table 8

ANOVA PRP

Variables	df	p	η^2	η^2_p
Indicators	4	<.001	0.96	0.97
PP	3	.282	0	0.08

4. Discussions and Conclusions

From a ***statistical standpoint***, the findings indicate that playing position does not have a statistically significant impact on postural stability in female soccer players, reinforcing the importance of neuromuscular conditioning [13] and targeted training over positional demands.

Nevertheless, from ***a performance standpoint***, the variations in performance metrics across positions reflect the specific physical and neuromuscular demands of each role.

Goalkeepers (GK) consistently outperformed all other positions across all measures. They recorded the highest static balance (82.67%), lateral dynamic balance (84.33%), vertical dynamic balance (85.67%), and proprioception (80%), with the smallest postural deviations in both anterior-posterior and lateral directions. Their superior postural control supports their need for rapid positional adjustments, explosive movements, and stability during reactive saves.

Defenders (DEF) performed better than midfielders and forwards but lower than goalkeepers. Their static balance (76.14%) and lateral dynamic balance (76.86%) were moderate, while their vertical dynamic balance (71.67%) was better than that of midfielders (65.56%) and forwards (66%). Defenders exhibited lower lateral deviations than both midfielders and forwards, reflecting greater postural stability, which is essential for defensive positioning, lateral responsiveness, and maintaining stability under external force.

Midfielders (MID) recorded the lowest performance across multiple balance and proprioception measures. Their static balance (77.94%) was lower than that of goalkeepers and forwards, while their vertical dynamic balance (65.56%) was the lowest among all positions. Midfielders also demonstrated the greatest backward deviations (-4.13° VDB, -1.77° PRP), indicating challenges in maintaining postural stability during movement transitions. Their proprioception (66.11%) was the weakest, suggesting difficulties in adjusting to rapid directional changes and maintaining balance during high-intensity play.

*Forwards (*FWD) performed better than midfielders but lower than defenders and goalkeepers. Their static balance (78.57%) was moderate, but their lateral dynamic balance (74.71%) and vertical dynamic balance (66%) were lower than those of defenders and goalkeepers. Forwards exhibited the highest lateral deviations (-4.4° left, 4.28° right in LDB), indicating

instability in side-to-side movements, which may be attributed to the need for rapid accelerations, quick directional changes, and agility in offensive play. Their proprioception (70.71%) was higher than that of midfielders (66.11%) but lower than that of defenders (68.86%) and goalkeepers (80%).

These results provide valuable insights for designing targeted conditioning programs. In real-world applications, our results indicate their ***practical significance*** [2, 9, 14]. This emphasizes the importance of targeted proprioceptive and balance training to optimize stability, reduce injury risk, and enhance performance [11, 12, 15]. The review data can inform position-specific training and coaching for match-play [3].

Forwards may benefit from engaging in reactive agility drills to potentially improve dynamic stability and directional control.

Midfielders might require multi-directional proprioception training to help enhance postural control during high-intensity transitions.

Defenders could focus on eccentric strength training and lateral stability exercises to support postural endurance under defensive pressure.

Goalkeepers may find value in explosive plyometric exercises combined with sensorimotor training to help sustain their superior reaction-based postural control.

While this study provides valuable insights into postural balance and proprioception in female soccer players, several limitations must be considered. The relatively small sample size (N = 49) may restrict the generalizability of the findings, particularly regarding positional differences at higher competitive levels.

Additionally, classifying players based on broad positional categories (e.g., defender or midfielder) may not accurately reflect the specific movement demands of central versus wide positions.

Future research should incorporate larger sample sizes to allow for a more precise positional analysis. Moreover, while standardized balance platform assessments provide reliable measurements, they do not fully replicate the dynamic, sport-specific conditions of match play.

In conclusion, while statistical analysis did not show a significant positional effect on balance and proprioception, the observed variations in performance metrics suggest that playing role influences the functional application of these abilities. These insights can inform evidence-based training programs designed to optimize stability, neuromuscular coordination, and injury prevention in female football players.

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