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Original Article

Position-Specific Physiological Profiles: A Comparative Analysis of Forced Vital Capacity, Blood Pressure, Heart Rate, and VO2 Max in Inter-University Soccer Players

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Abstract

This cross-sectional study investigated differences in key physiological parameters forced vital capacity (FVC), systolic and diastolic blood pressure (SBP and DBP), heart rate (HR), and VO2 max among 150 inter-university soccer players aged 18–24 years, categorized by playing position: defenders (n = 50), midfielders (n = 50), and forwards (n = 50). Data were collected using standardized spirometry, sphygmomanometry, heart rate monitoring, and treadmill ergometry tests conducted between September 25 and November 15, 2023. One-way ANOVA revealed significant differences in FVC (F2, 147) = 4.476, p = 0.016) and HR (F2, 147) = 19.624, p < 0.001), with defenders exhibiting the highest FVC and forwards the highest HR. No significant differences were found in SBP (F2, 147) = 1.712, p = 0.194), DBP (F2, 147) = 2.984, p = 0.093), or VO2 max (F2, 147) = 2.892, p = 0.091). Post-hoc Scheffé tests confirmed position-specific variations, particularly between defenders and forwards for FVC, and between forwards/defenders and midfielders for HR. These findings underscore the need for tailored training programs to optimize performance and reduce injury risk, aligning with prior research on positional demands in soccer.

Keywords: *soccer, physiological parameters, playing positions, forced vital capacity, VO2 max, heart rate, blood pressure*

Introduction

Physical conditioning and physiological fitness are essential for optimal performance in soccer, a sport characterized by intermittent high-intensity efforts such as sprinting, jumping, and rapid directional changes. These demands impose substantial stress on the cardiovascular, muscular, and respiratory systems (Bangsbo, 2006). Consequently, parameters like forced vital capacity (FVC), heart rate (HR), blood pressure (BP), and VO2 max are critical for evaluating an athlete's endurance, strength, and recovery capacity, while also informing injury prevention strategies (Reilly & Drust, 2003; Chtourou & Souissi, 2012; Naderi et al., 2021).

Soccer positions forwards, midfielders, and defenders impose distinct physical requirements, leading to variations in physiological profiles (note: goalkeepers were excluded due to sample composition). Forwards rely on explosive anaerobic power for sprints, midfielders on aerobic endurance for extensive ground coverage, and defenders on a blend of strength and cardiovascular fitness for tackling and aerial duels (Bangsbo et al., 2006; Hoff et al., 2002). Understanding these differences enables position-specific training, enhancing performance and well-being.

Research Objectives

1. To compare forced vital capacity (FVC) among soccer players in different playing positions.
2. To compare systolic and diastolic blood pressure (SBP and DBP) among soccer players in different playing positions.
3. To compare heart rate (HR) among soccer players in different playing positions.
4. To compare VO2 max among soccer players in different playing positions.

Literature Review

Prior research highlights the pivotal role of physiological parameters in soccer performance, with positional differences influencing training efficacy.

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FVC, an indicator of lung function, supports oxygen delivery during prolonged exertion (Matsuo et al., 2015). Lower resting HR and BP signify cardiovascular efficiency (Hoffman, 2018; Sallis et al., 2015), while VO2 max reflects aerobic capacity essential for sustained intensity (Bouchard et al., 2017).

Studies on positional variances demonstrate that midfielders often exhibit superior VO2 max due to continuous activity (Hoff et al., 2002), whereas forwards show elevated HR from anaerobic bursts (Reilly & Drust, 2003). Bangsbo (2006) emphasized aerobic and anaerobic system interplay, with defenders benefiting from enhanced respiratory efficiency for power-based tasks.

Recent investigations reinforce these patterns. Kumaresan and James (2024) found 12-week resistance training improved bio-motor fitness (speed, flexibility, agility) in young volleyball players, suggesting similar benefits for soccer. Mohan et al. (2024) reported anaerobic training enhanced motor fitness and skills in college soccer players, outperforming skill-only or control groups. Kubala (2024) assessed U17 soccer players' fitness via speed and jump tests, linking results to positional roles. Nayyef (2024) demonstrated tailored exercises boosted motor skills in student athletes, advocating focused regimens.

Reza et al. (2024) identified sport-specific differences in agility, speed, and endurance across athletic s, basketball, cricket, soccer, handball, and volleyball, urging customized training. Kodeeswaran and Murugavel (2023) compared soccer referees and players, finding players superior in speed and endurance. Rahaman and Sanjit (2023) noted disparities in endurance and leg strength between university soccer cohorts, attributing variations to training contexts.

Erol (2022) showed eccentric training outperformed concentric methods in enhancing lower-body strength and jumps in soccer players. Mroczek et al. (2022) observed age-related increases in body mass and muscle among youth players. Sarkar and Kandar (2022) linked motor fitness training to improved daily and athletic performance. Shen et al. (2021) detailed positional variances in agility, power, and endurance. Daga et al. (2021) favored multilateral game-based training for U9 players' fitness without skill compromise. Aychiluhim and Deyou (2020) correlated agility and speed with elite performance. Bennett (2020) differentiated academy players by physical competencies, and Brien-Smith et al. (2020) found minimal sex differences in youth soccer fitness, though soccer-specific gaps persisted. Collectively, these studies affirm positional physiological heterogeneity, supporting targeted interventions.

Methodology

Study Design

This cross-sectional study examined physiological differences among soccer players by position at a single time point.

Participants

Participants comprised 150 inter-university soccer players from Bilaspur, Chhattisgarh, aged 18–24 years (M = 21.2, SD = 1.8), from diverse socioeconomic backgrounds. They were grouped as defenders (n = 50), midfielders (n = 50), and forwards (n = 50), based on primary positional roles in tournaments. Inclusion criteria: active tournament participation, regular training, and absence of cardiovascular or respiratory conditions. Ethical approval was obtained from the institutional review board, with informed consent from all participants.

Variables and Measures

Variables, selected from literature (e.g., Bangsbo, 2006; Hoff et al., 2002), included FVC, SBP, DBP, HR, and VO2 max.

- **FVC:** Measured via calibrated spirometer (liters).
- **SBP/DBP:** Assessed with digital sphygmomanometer (mmHg).
- **HR:** Recorded using polar heart rate monitor (beats/min).
- **VO2 max:** Estimated via Bruce treadmill protocol (mL/kg/min).

Tests demonstrated high reliability (intraclass correlation coefficients > 0.90).

Procedure

Testing occurred in evenings (4:00–6:00 PM), September 25–November 15, 2023, to control environmental variables (temperature: 24–28°C; humidity: 60–70%). Participants rested 10 min pre-test; administrators standardized encouragement. Data were collected post-rest for resting values.

Data Analysis

Descriptive statistics (means, standard deviations) summarized data. One-way ANOVA tested group differences (α = 0.05), with Scheffé post-hoc for significant effects. Analyses used SPSS (v.27); assumptions (normality, homogeneity) were verified via Shapiro-Wilk and Levene's tests.

Results

Forced Vital Capacity (FVC)

Table 1 presents descriptive statistics for FVC. Defenders showed the highest mean FVC (M = 4.53 L), followed by midfielders (M = 4.37 L) and forwards (M = 4.21 L). Figure 1 illustrates mean differences. ANOVA indicated significance (F(2, 147) = 4.476, p = 0.016; see Table 2). Scheffé tests (Table 3) revealed differences between defenders and forwards (p = 0.012).

Table 1. Descriptive Statistics for Forced Vital Capacity by Playing Position

Position	n	M (L)	SD
Defenders	50	4.53	0.53
Midfielders	50	4.37	0.53
Forwards	50	4.21	0.53

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Figure 1. Mean Scores of Forced Vital Capacity by Playing Position

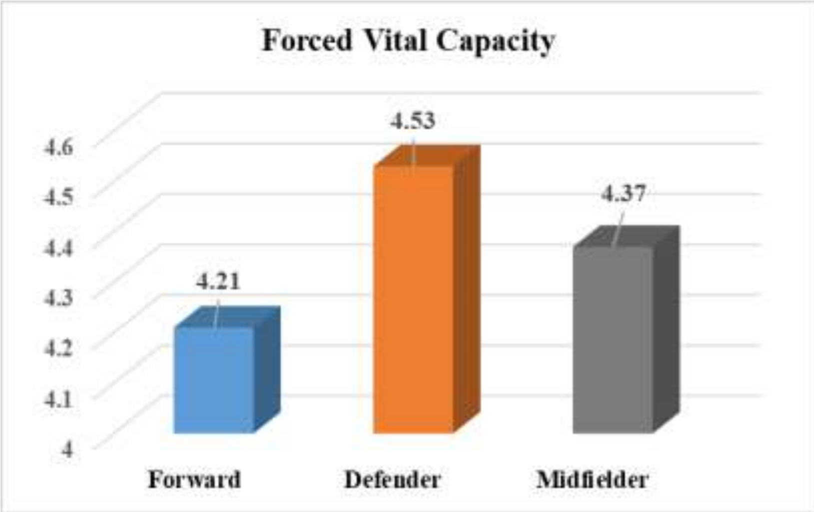

Table 2. ANOVA Results for Forced Vital Capacity

Source	**SS**	***df***	**MS**	***F***	***p***
Between Groups	2.56	2	1.28	4.476	0.016
Within Groups	42.04	147	0.29		
Total	44.60	149			

Table 3. Scheffé Post-Hoc Comparisons for Forced Vital Capacity

Comparison	**Mean Difference**	***p***
Defenders vs. Forwards	0.32	0.012
Defenders vs. Midfielders	0.16	0.245
Midfielders vs. Forwards	0.16	0.278

Blood Pressure

Systolic Blood Pressure (SBP)

Table 4 presents descriptives. Forwards had the highest SBP (M = 147.63 mmHg), then defenders (M = 134.84 mmHg) and midfielders (M = 124.21 mmHg). Figure 2 illustrates means. ANOVA was nonsignificant ($F(2, 147) = 1.712$, $p = 0.194$; Table 5).

Table 4. Descriptive Statistics for Systolic Blood Pressure by Playing Position

Position	***n***	***M* (mmHg)**	***SD***
Defenders	50	134.84	63.37
Midfielders	50	124.21	63.37
Forwards	50	147.63	63.37

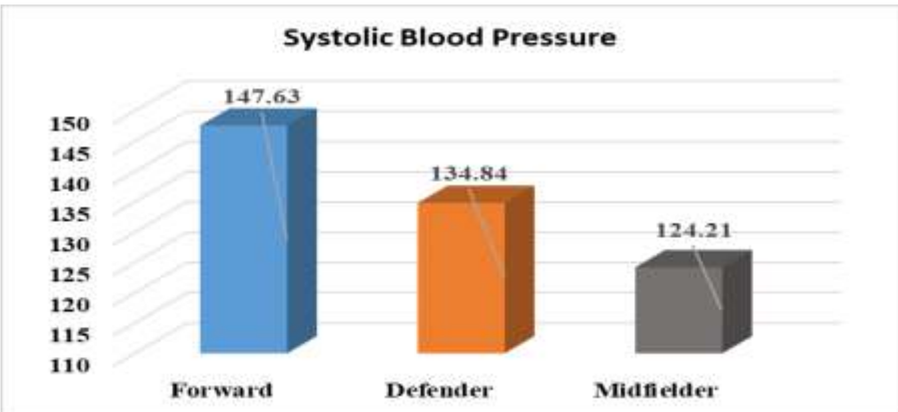

Figure 2. Mean Scores of Systolic Blood Pressure by Playing Position

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Table 5. ANOVA Results for Systolic Blood Pressure

Source	SS	*df*	MS	*F*	*p*
Between Groups	97.26	2	48.63	2.984	0.093
Within Groups	2395.73	147	16.30		
Total	2492.99	149			

Diastolic Blood Pressure (DBP)

Table 6 presents descriptives. Forwards exhibited highest DBP (M = 79.80 mmHg, SD = 4.04), followed by defenders (M = 78.73 mmHg, SD = 4.04) and midfielders (M = 77.83 mmHg, SD = 4.04). Figure 3 illustrates means. ANOVA was nonsignificant (F(2, 147) = 2.984, p = 0.093; Table 7).

Table 6. Descriptive Statistics for Diastolic Blood Pressure by Playing Position

Position	*n*	*M* (mmHg)	*SD*
Defenders	50	78.73	4.04
Midfielders	50	77.83	4.04
Forwards	50	79.80	4.04

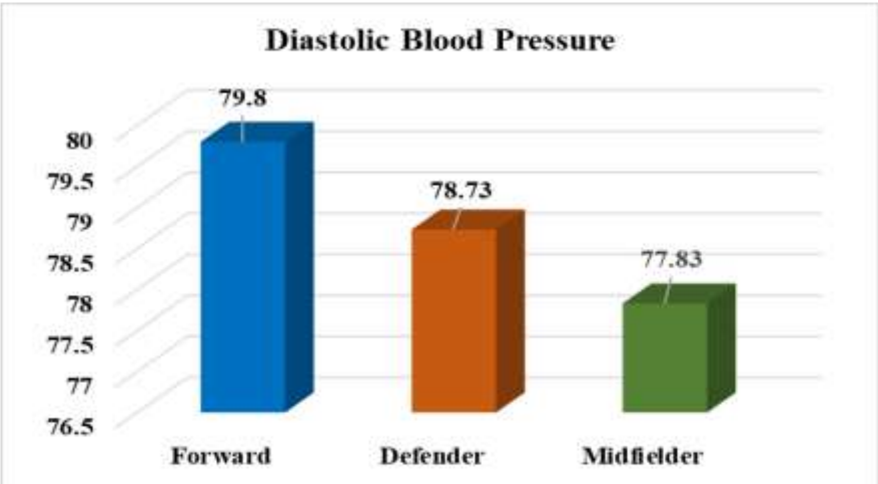

Figure 3. Mean Scores of Diastolic Blood Pressure by Playing Position

Table 7. ANOVA Results for Diastolic Blood Pressure

Source	SS	*df*	MS	*F*	*p*
Between Groups	97.26	2	48.63	2.984	0.093
Within Groups	2395.73	147	16.30		
Total	2492.99	149			

Heart Rate (HR)

Table 8 presents descriptives. Forwards had the highest HR (M = 71.84 bpm, SD = 2.78), then defenders (M = 70.68 bpm, SD = 2.78) and midfielders (M = 68.41 bpm, SD = 2.78). Figure 4 illustrates means. ANOVA showed significance (F(2, 147) = 19.624, p < 0.001; Table 9). Scheffé tests (Table 10) confirmed differences: forwards vs. midfielders (p < 0.001), defenders vs. midfielders (p = 0.002).

Table 8. Descriptive Statistics for Heart Rate by Playing Position

Position	*n*	*M* (bpm)	*SD*
Defenders	50	70.68	2.78
Midfielders	50	68.41	2.78
Forwards	50	71.84	2.78

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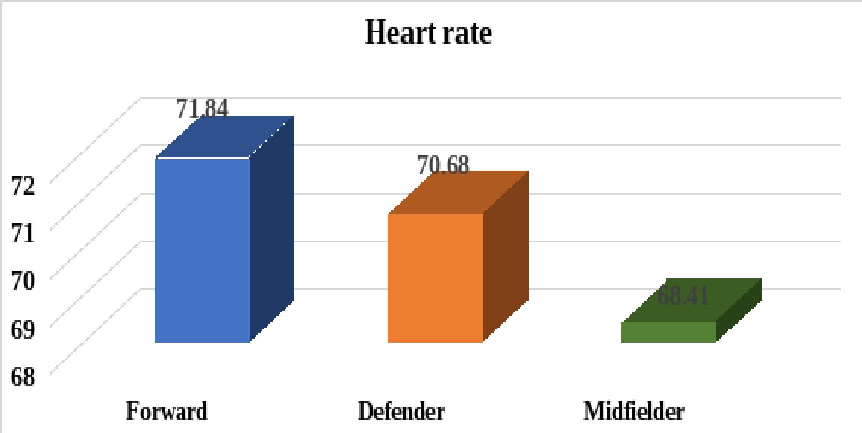

Figure 4. Mean Scores of Heart Rate by Playing Position

Table 9. ANOVA Results for Heart Rate

Source	SS	*df*	MS	*F*	*p*
Between Groups	304.39	2	152.20	19.624	<0.001
Within Groups	1140.07	147	7.76		
Total	1444.46	149			

Table 10. Scheffé Post-Hoc Comparisons for Heart Rate

Comparison	Mean Difference	p
Defenders vs. Midfielders	2.27	0.002
Defenders vs. Forwards	-1.16	0.345
Midfielders vs. Forwards	-3.43	<0.001

VO2 Max

Table 11 presents descriptives. Defenders had highest VO2 max (M = 68.70 mL/kg/min, SD = 17.86), then forwards (M = 63.92 mL/kg/min, SD = 17.86) and midfielders (M = 60.13 mL/kg/min, SD = 17.86). Figure 5 illustrates means. ANOVA was nonsignificant (F(2, 147) = 2.892, p = 0.091; Table 12).

Table 11. Descriptive Statistics for VO2 Max by Playing Position

Position	*n*	*M* (mL/kg/min)	*SD*
Defenders	50	68.70	17.86
Midfielders	50	60.13	17.86
Forwards	50	63.92	17.86

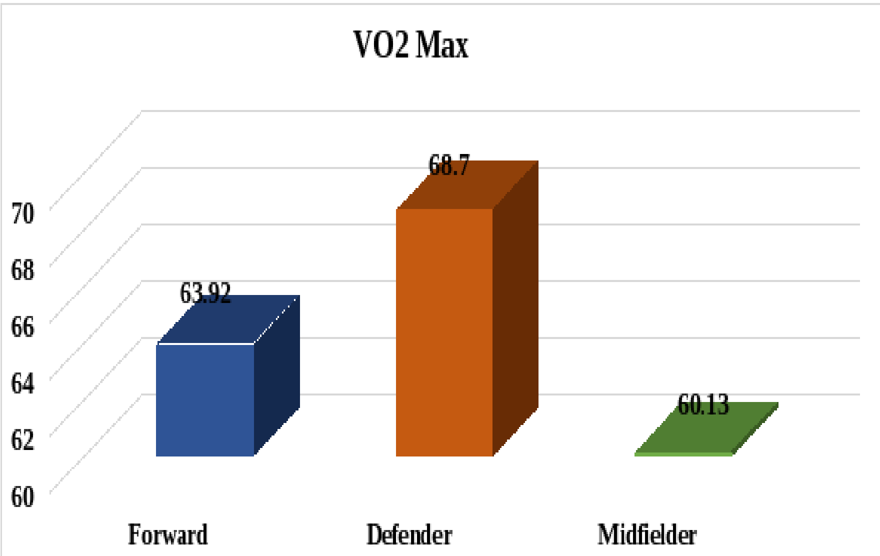

Figure 5. Mean Scores of VO2 Max by Playing Position

Table 12. ANOVA Results for VO2 Max

Source	SS	*df*	MS	*F*	*p*
Between Groups	1844.29	2	922.15	2.892	0.091
Within Groups	46872.52	147	318.86		
Total	48716.81	149			

Discussion

The results indicate position-specific physiological variations. Significant FVC differences (defenders > forwards) reflect enhanced respiratory efficiency from strength-oriented training (Matsuo et al., 2015). Forwards' elevated HR corresponds to sprint demands (Reilly & Drust, 2003), while midfielders' lower HR suggests aerobic adaptations (Hoff et al., 2002). Nonsignificant BP and VO2 max results highlight individual factors (e.g., genetics) over positional effects, partially diverging from prior work (Hoff et al., 2002) but aligning with training variability emphases (Bangsbo, 2006). The large SBP SD indicates high inter-individual variability, likely from post-rest measurement.

These findings advocate custom-made programs: HIIT for forwards' cardiovascular needs, endurance runs for midfielders, and strength-anaerobic hybrids for defenders. Limitations encompass cross-sectional design, uncontrolled confounders (diet, genetics), and BP measurement variability. Future longitudinal studies with elite athletes and larger samples, incorporating nutritional controls, are warranted.

Conclusion

This cross-sectional study elucidates positional physiological disparities among inter-university soccer players, identifying significant differences in forced vital capacity and heart rate, wherein defenders displayed superior forced vital capacity indicative of robust respiratory efficiency, and forwards showed elevated resting heart rate tied to anaerobic sprint demands. In contrast, nonsignificant variations in systolic/diastolic blood pressure and VO2 max emphasize individual influences such as genetics and training exposure over positional dictates. These revelations endorse bespoke conditioning: high-intensity interval training for forwards to fortify cardiovascular endurance, aerobic tempo runs for midfielders to extend coverage capacity, and plyometric-strength fusions for defenders to heighten explosive power. Integrating periodic assessments can elevate performance, diminish injury susceptibility through fatigue mitigation, and promote team synergy. Aligning with extant scholarship on tailored regimens, this research propels soccer physiology toward precision interventions. Prospective longitudinal trials in elite settings, factoring nutrition and recovery, promise deeper insights into adaptive dynamics for worldwide coaching efficacy.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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