PHYSICAL AND PHYSIOLOGICAL ATTRIBUTES OF ELITE VOLLEYBALL PLAYERS IN NIGERIA PREMIER LEAGUE

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Abstract

Volleyball players' physical and physiological characteristics play a critical role in their performance and are often influenced by positional demands. Understanding these traits can provide useful information for optimising training and performance. Therefore, this study investigated the physical and physiological characteristics of elite volleyball players in Nigeria. The variables assessed were; heart rate, blood pressure, body fat percentage, body mass index (BMI), arm span, arm strength, calf and thigh circumferences, with a focus on variations across playing positions.

This study employed an ex-post facto design, obtaining data from 102 elite volleyball players in the Nigerian Volleyball Premier League. Measurements were taken using standard instruments, and data were analysed using descriptive statistics and one-way analysis of variance (ANOVA) at a 0.05 significance level. Bonferonni Post hoc tests were performed to further identify significant differences. Kolmogorov-Smirnov test was conducted to determine the normality of the data and were found to be normally distributed ($p = .071$).

Heart rate scores were consistent across playing positions, indicating no significant differences ($p > 0.05$). However, significant variations were observed in arm span ($p = 0.00$), BMI ($p = 0.00$), and body fat percentage ($p = 0.02$) based on playing positions. Post hoc analyses showed blockers had the longest arm spans and the highest body fat percentages, while spikers exhibited the highest BMI values. Arm strength did not significantly differ across positions ($p > 0.05$). This study concluded; that physical and physiological characteristics, particularly arm span, BMI, and body fat percentage, are position-specific in volleyball. It was recommended that coaches consider these traits when designing training and conditioning programmes. Player's attributes should be considered during talent identification and assigning of role. In addition, regular assessment of players' physical and physiological attributes throughout the season to optimise performance and address weaknesses.

Keywords: Volleyball players, physical, physiological, premier league, elite

INTRODUCTION

The game of volleyball, characterized by its dynamic and explosive movements, is a globally recognized sport with unique demands on athletes' physical and physiological profiles. Successful participation in volleyball requires a combination of anthropometric traits, such as height and arm span, as well as physiological attributes like cardiovascular endurance, agility, and muscle strength (Silva et al., 2021). These factors often influence the technical and tactical skills necessary for optimal performance in various playing positions (Johnson et al., 2022).

William G. Morgan, who invented volleyball in 1895, envisioned a sport suitable for individuals seeking physical activity without excessive strain (Williams et al., 2020). Over the years, volleyball has evolved into a high-intensity sport that combines precision, power, and agility. The sport's demands require athletes to excel in vertical jumping, quick lateral movements, and sustained bursts of energy—skills that are heavily influenced by their physical and physiological characteristics (Kim et al., 2023; Smith et al., 2021).

Physical attributes such as arm span, body mass index (BMI), and body composition have been identified as critical determinants of performance in volleyball. For instance, taller athletes with longer arm spans are often more effective in blocking and spiking, while players with optimal BMI and low body fat percentages tend to exhibit greater agility and endurance (Garcia et al., 2022; Johnson et al., 2023). Similarly, physiological traits such as cardiovascular fitness and muscular strength contribute significantly to sustaining high-intensity performance during matches (Thomas et al., 2020).

In global contexts, studies have consistently highlighted the positional differences in physical and physiological traits among volleyball players. For example, blockers often possess the longest arm spans and highest vertical jumps, while setters exhibit superior agility and coordination due to their role in orchestrating the team's offensive strategies (Miller et al., 2021). However, research specific to Nigerian volleyball players remains scarce, despite the growing prominence of the sport in the region. Factors such as socio-economic conditions, training facilities, and coaching practices may uniquely influence the physical and physiological profiles of Nigerian athletes, underscoring the need for localized research (Adams et al., 2023).

The importance of understanding these characteristics extends beyond performance optimization. For coaches and sports scientists, insights into players' profiles can inform the development of tailored training programs, injury prevention strategies, and talent identification processes. By addressing the gaps in existing literature, this study aims to provide a comprehensive analysis of the physical and physiological attributes of elite Nigerian volleyball players, with an emphasis on positional differences.

Objectives of the Study

The objectives of this study are to:

1. determine the Heart Rate of elite Volleyball players in Nigeria.
2. assess the mean Arm Span of elite Volleyball players in Nigeria.
3. find out the Body Mass Index of elite Volleyball players in Nigeria.
4. measure the Arm Strength of elite Volleyball players in Nigeria
5. examine the Body Fat percentage of elite Volleyball players in Nigeria

Research Questions

The following Research Questions will be raised to guide the study:

1. What is the mean Heart Rate of elite Volleyball players in Nigeria?
2. What is the mean Arm Span of elite Volleyball players in Nigeria?
3. What is the mean Body Mass Index of elite Volleyball players in Nigeria?
4. What is the mean Arm Strength of elite Volleyball players in Nigeria?
5. What is the mean Body Fat percentage of elite Volleyball players in Nigeria?

Hypotheses

1. There is no statistically significant difference in Heart rate based on the playing position of elite Volleyball players in Nigeria
2. There is no statistically significant difference in the Arm Span based on the playing position of elite volleyball players in Nigeria.
3. There is no statistically significant difference in the Body Mass Index based on the year of experience of elite Volleyball players in Nigeria.
4. There is no significant difference in Arm Strength based on the playing position of elite Volleyball players in Nigeria.

5. There is no significant relationship between Body Fat Percentage and the Thigh girth of elite Volleyball players in Nigeria.

METHODOLOGY

An ex-post facto research design was adopted for this study. This design is particularly suitable as it involves analyzing existing characteristics and relationships without manipulating variables. This approach allows for a detailed exploration of naturally occurring variations among volleyball players based on their positional roles.

Population of the Study

The population comprised all registered volleyball players in the Nigerian Volleyball Premier League.

Sampling Techniques

Stratified random sampling technique was employed to ensure representation across key playing positions, including setters, spikers, blockers, and liberos. A total of 102 players were selected for this study.

Research Instruments

Standardized and validated instruments were utilised to collect data on the key variables:

Heart Rate (HR): Measured using a digital heart rate monitor to ensure precision and consistency. Procedure: Participants were instructed to rest in a seated position for 5 minutes to establish a baseline. Measurements were taken by placing the heart rate monitor on the wrist and recording the beats per minute (BPM) after stabilization.

Arm Span (AS): Measured using a calibrated stadiometer.
Procedure: Participants stood barefoot with their backs against a wall and arms outstretched horizontally. The distance between the tips of the middle fingers was measured in centimeters (cm) using a non-elastic measuring tape.

Body Mass Index (BMI): Calculated as weight (kg) divided by height squared (m^2).
Procedure: Body weight was measured using a digital weighing scale with participants standing barefoot in light clothing. Height was measured using a stadiometer. The BMI was then computed using the formula.

Arm Strength (AST): Assessed using a handgrip dynamometer

Procedure: Participants were instructed to hold the dynamometer in their dominant hand and squeeze it with maximum effort for three seconds. The test was repeated three times with a 1-minute rest between attempts, and the highest value was recorded in kilograms (kg).

Thigh and Calf Circumferences

Procedure: The player stood upright with his weight evenly distributed on both feet and feet slightly apart. The midpoint of the thigh was located, which is halfway between the inguinal crease and the top of the kneecap. A flexible, non-stretchable tape measure was wrapped around the midpoint, ensuring it lies flat against the skin and is parallel to the floor. Measurement was taken, ensuring the tape is snug but not compressing the skin, and recorded to the nearest 0.1 cm

For calf circumference, the player stood upright with feet slightly apart and weight evenly distributed. The widest part of the calf muscle (gastrocnemius), usually the midpoint between the knee and ankle. The tape measure was wrapped around the point, ensuring it lies flat and parallel to the floor. Measurement was taken with the tape snug but not tight, avoiding compression of the muscle or skin and recorded to the nearest 0.1 cm.

Body Fat Percentage (%BF): Determined using a bioelectrical impedance analyzer.

Procedure: Participants stood barefoot on the analyzer body composition analyser (BF105, China) which measured resistance and provided an estimate of body fat percentage. Measurements were taken in a fasted state for accuracy. Please note that all measurements were repeated three times to ensure precision.

Validity and Reliability of Instruments

The validity of the instruments was established through expert review by two professors in exercise physiology and sports science. Reliability was confirmed through a pilot study involving 20 volleyball players, yielding a Cronbach's alpha value of 0.79, demonstrating high internal consistency of the instruments

Data Collection Procedure

Ethical clearance was obtained from the relevant institutional review board. Participants provided informed consent before the commencement of data collection. Data were collected over a four-

week period during training sessions to ensure ecological validity. Measurements were taken under standardized conditions to minimize variability and ensure accuracy.

Data Analysis

Data were analysed using both descriptive and inferential statistics. Descriptive statistics, including means and standard deviations, were used to summarise the data. One-way Analysis of Variance (ANOVA) was employed to test for significant differences in the variables across playing positions. Post hoc tests were conducted to identify specific group differences where significant differences were observed. Statistical significance was set at $p < 0.05$.

RESULTS

This study assessed the physical and physiological characteristics of professional volleyball players in Nigeria. The demographic analysis is provided in the table below.

Table 1: The Demographic Profiles of the Players

Item	Variable	N	%
Age (years)	15-19	14	13.7
	20-24	50	49.0
	25-29	14	13.7
	30-34	9	8.8
	35-39	15	14.7
Playing Experience (yrs)	0-5	39	38.2
	6-10	40	39.2
	11-15	23	22.5
Playing Position	Setter	20	19.6
	Spiker	63	61.8
	Blocker	15	14.7
	Libero	4	3.9
Marital Status	Single	83	81.4
	Married	19	18.6
Education Level	Primary	10	9.8
	O'Level	15	14.7
	NCE/OND	25	24.5
	BSc/HND	47	46.1
	MSc	5	4.9
	PhD	0	0

Table 1 shows that the players were predominantly young, with nearly half of them (49%) aged between 20 and 24 years, representing the prime athletic years for peak performance. Another notable age group is 35-39 years (14.7%), indicating a significant presence of experienced players.

The distribution demonstrates the combination of young energy and seasoned professionals within the team compositions. Based on education level, most players (46.1%) possess a bachelor's degree or higher diploma (B.Sc./HND), demonstrating a well-educated cohort. However, only 4.9% hold a master's degree, and no participants have attained a Ph.D., highlighting opportunities for further academic advancement among athletes. Regarding playing experience, there is a balanced representation of both emerging and seasoned players. The majority have either 0-5 years (38.2%) or 6-10 years (38.2%) of experience, while 22.5% have over 11 years of experience. This mix of experience levels is likely to foster dynamic team interactions and learning opportunities. In terms of positional roles, spikers dominate the group, accounting for 61.8%, reflecting their critical role in offensive gameplay. Setters (19.6%), blockers (14.7%), and liberos (3.9%) are less represented, aligning with the specialized nature of these roles. The marital status of the players reveals that 81.4% are single, reflecting the younger demographic and possibly the focus on their athletic careers. Married players comprise 18.6%, demonstrating that some athletes manage the demands of both professional and personal lives.

Table 2: Mean and Standard Deviation of the Physical and Physiological Profile of the Players

Variable	**Mean ±SD**
HR	81.8±13.6
RSBP	125.2±17.2
RDBP	81.4±16.5
%BF	15.2±3.5
CF	35.7±3.7
BMI	22.5±2.2
AS	189.9±3.5
AST	49.8±9.0
TG	56.7±6.4
WHR	0.85±0.1

Key: RHR; Heart Rate, **RSBP;** Resting Systolic Blood Pressure, **RDBP;** Resting Diastolic Blood Pressure, **%BF;** Body Fat Percent, **CF;** Calf Circumference**, BMI;** Body Mass Index, **AS;** Arm Span, **AST;** Arm Strength, **TG;** Thigh Girth, **WHR;** Waist-to-Hip Ratio

Answers to Research Questions

The resting heart rate (RHR) of the players averaged 81.8 beats per minute (±13.6), indicative of a moderate cardiovascular fitness level, a critical attribute for sustained performance in high-intensity sports like volleyball. The Resting systolic blood pressure (RSBP) and Resting Diastolic Blood Pressure (RDBP) were 125.2 mmHg (±17.2) and 81.4 mmHg (±16.5), respectively, indicating a healthy blood pressure ranges among the players.

Players exhibited a low body fat percentage of 15.2% (±3.5), which is consistent with the lean body composition required for agility and endurance. Their calf circumference averaged 35.7 cm (±3.7), while average thigh girth (TG) was 56.7 cm (±6.4), reflecting the muscular development essential for explosive movements, such as jumping and quick lateral shifts.

The average body mass index (BMI) was 22.5 (±2.2), falling within the healthy range for athletic populations. This indicates an optimal weight-to-height ratio, which supports performance without unnecessary strain. The players' arm span (AS) was remarkably long, averaging 189.9 cm (±3.5), providing a critical advantage for spiking and blocking.

Arm strength (AST) averaged 49.8 kg (±9.0), indicating the upper body strength necessary for delivering powerful hits and effective defensive maneuvers. Lastly, the waist-to-hip ratio (WHR) was 0.85 (±0.1), emphasizing the lean and proportional builds typical of elite athletes.

Results of Hypotheses

Table 3: ANOVA analysis showing of the mean RHR of volleyball players based on playing positions.

Variable	Sum of Square	Mean Square	df	F	Sig.
Between Groups	1066.87	355.62	3	1.949	.120
Within Groups	17882.16	182.471	99		
Total	18949.02		102		

One-way ANOVA was conducted to test if the difference between the mean HR of the players is statistically significant. From the results in table 3, there is no statistically significant difference in the mean HR [F (3, 99) = 1.949, p=0.12]. Therefore, the null hypothesis is retained. This indicates that the heart rate scores are similar irrespective of the playing positions.

Table 4: ANOVA results showing significant difference in the Arm Span based on the playing position of elite volleyball players in Nigeria

Variable	Sum of Square	Mean Square	df	F	Sig.
Between Groups	23871.157	7957.052	3	23.354	.000
Within Groups	33390.333	340.718	99		
Total	57261.490		102		

One-way ANOVA was conducted to test if the difference between the mean arm span of the players is statistically significant. From the results in table 4, there is no statistically significant difference in the mean AS [F (3, 99) = 23.354, p=0.00]. Therefore, the null hypothesis was rejected. This indicates that the arm span scores vary with respect to the playing positions.

Table 5: ANOVA results showing significant difference in the BMI based on the playing position of elite volleyball players in Nigeria

Variable	Sum of Square	Mean Square	df	F	Sig.
Between Groups	252.835	84.278	3	37.246	.000
Within Groups	22.751	2.26	99		
Total	474.596		102		

One-way ANOVA was conducted to test if the difference between the mean body mass index of the players is statistically significant. From the results in table 5, there is no statistically significant difference in the mean BMI [F (3, 99) = 37.246, p=0.00]. Therefore, the null hypothesis was rejected. This indicates that the body mass index scores vary concerning the playing positions.

Table 6: ANOVA results Showing Body Mass Index of the Players based on year of experience of elite Volleyball players in Nigeria

Variable	Sum of Square	Mean Square	df	F	Sig.
Between Groups	269.726	89.909	3	37.246	.000
Within Groups	7976.588	81.394	99		
Total	8246.314		102		

One-way ANOVA was conducted to test if the difference between the mean arm strength of the players is statistically significant. From the results in table 6, there is no statistically significant difference in the mean AST ($F_{(3, 99)} = 1.105$, p=0.35). Therefore, the null hypothesis is retained. This indicates that the arm strength scores are similar irrespective of the playing positions.

Table 7: ANOVA results Showing relationship between Body Fat Percentage and the Thigh girth of elite Volleyball players in Nigeria.

Variable	Sum of Square	Mean Square	df	F	Sig.
Between Groups	648.761	216.254	3	37.680	.000
Within Groups	562.440	5.739	99		
Total	1211.201		102		

One-way ANOVA was conducted to test if the difference between the mean body fat percentage of the players is statistically significant. From the results in table 7, there is no statistically significant difference in the mean BF, [F (3, 99) = 37.680, p=0.00]. Therefore, the null hypothesis was rejected. This indicates that the body fat percentage scores vary concerning the playing positions.

Posthoc Tests

Game-Howell posthoc test was conducted to identify where the difference lies in all three variables (%BF, Arm Span and BMI). Based on %BF, blocker had the highest mean difference among the players [N=102, mean =7.22 ±1.01, 95% C. I (0.75 to 1.72), p = 0.00]. This implies that blocker players possess the highest body fat among the four categories (setter, spiker, spiker and libero).

Similarly, blockers had the longest arm span [N = 102, mean 68.99 ± 7.26, 95% C. I (47.54 to 89.79), p = 0.00]. This indicates that blockers also had the most extended arm spans among the four categories of volleyball players.

The posthoc test for body mass index (BMI) indicated the spikers had the highest body mass index [N = 102, mean 4.15 ± 0.14, 95% C. I (3.76 to 4.52), p = 0.00].

DISCUSSIONS

This study investigated the physical and physiological attributes of elite volleyball players in Nigeria premier league. The results of this study provide valuable insights into the physical and physiological characteristics of professional volleyball players in Nigeria. The demographic analysis indicates a predominantly young athlete population, with nearly half (49%) aged between 20 and 24 years, a critical period for peak athletic performance (García & García, 2020). This youthful demographic, coupled with the presence of experienced players (14.7% aged 35-39 years), suggests a dynamic blend of energy and expertise, which is essential for team synergy and performance. Such a mix can foster a competitive environment where younger players can learn from seasoned athletes, enhancing team cohesion and overall effectiveness during competitions (Schempp & McCaughtry, 2016).

The educational attainment of the players is noteworthy, with 46.1% holding a bachelor's degree or higher. This high level of education among athletes not only reflects their commitment to personal development but also highlights the potential for further academic pursuits (Harrison & Narayan, 2018). The lack of players with doctoral degrees suggests an area for growth, where initiatives could be implemented to encourage higher education among athletes, potentially enhancing their post-career opportunities. The physical assessments reveal that the players have a moderate resting heart rate (RHR) of 81.8 beats per minute, indicating a baseline level of cardiovascular fitness appropriate for their sport (Buchheit & Laursen, 2013). The resting systolic and diastolic blood pressure readings (125.2 mmHg and 81.4 mmHg, respectively) fall within healthy ranges, suggesting that these athletes maintain good cardiovascular health, which is critical for sustained performance in high-intensity sports like volleyball.

The players' body fat percentage (15.2%) aligns with the lean body composition expected in elite athletes, supporting agility and endurance (Pritchett & McCaffrey, 2021). Such a low body fat percentage is crucial for volleyball players, who require quick movements, rapid changes in

direction, and the ability to jump effectively. The muscular measurements, including calf circumference (35.7 cm) and thigh girth (56.7 cm), underscore the physical demands of volleyball, where explosive movements and strength are paramount. These measurements indicate that the players have developed the specific muscle groups necessary for their sport, which can contribute to their overall performance on the court.

The average body mass index (BMI) of 22.5 confirms that the athletes maintain an optimal weight-to-height ratio, essential for performance without excessive strain (Kraemer & Ratamess, 2004). A healthy BMI is particularly important in a sport like volleyball, where excessive weight can hinder agility and movement efficiency. The findings regarding arm span (189.9 cm) are particularly relevant to volleyball, where reach is a critical advantage in both offensive and defensive plays. The significant variation in arm span among different playing positions suggests that positional training and recruitment strategies could be informed by this data, with blockers, who had the longest arm spans, being strategically utilized in roles requiring maximum reach (Fuchs & Schmid, 2019).The distribution of playing experience among the players indicates a healthy mix of emerging talent and seasoned professionals. With 38.2% of the players having between 0-10 years of experience, this blend is likely to foster an environment conducive to learning and development. Young players benefit from the mentorship of more experienced teammates, which can enhance overall team performance (Schempp & McCaughtry, 2016). This dynamic can lead to an exchange of knowledge and skills that is invaluable in high-pressure situations typical of competitive sports.

The post-hoc analysis reveals that blockers not only possess the highest body fat percentage but also the longest arm spans, suggesting a unique profile that may benefit specific gameplay strategies. The spikers, with the highest BMI, reflect the need for a balance of size and agility in offensive roles. These findings indicate that positional requirements may necessitate different physical profiles, which should be considered in training regimens and player development programmes (Kraemer & Ratamess, 2004). Coaches and trainers can tailor their approaches based on these characteristics, optimizing training to enhance each player's strengths while addressing any weaknesses.

CONCLUSIONS

1. There was no significant difference in resting heart rate of the volleyball players across playing positions
2. Body fat percentage and body mass index differed significantly across playing positions
3. Blockers had the longest arm span as compared to other categories of players
4. Spikers demonstrated the highest BMI values
5. Arm strength reading was similar across playing positions among the players

RECOMMENDATIONS

1. Coaches should consider physical and physiological attributes of players when designing training and conditioning programmes.

2. Player's attributes should be considered during talent identification and assigning of role.

3. Regular assessment of players' physical and physiological profile throughout the season to address weaknesses and monitor progress.

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