OPEN ACCESS

Journal of Advances in Sports and Physical Education
Abbreviated Key Title: J Adv Sport Phys Edu
ISSN 2616-8642 (Print) |ISSN 2617-3905 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Gross Anatomical Anthropometry Association with Physical Fitness Performance among Adolescent Male Football Players in Bayelsa State, Nigeria: A Cross-Sectional Analysis

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DOI: https://doi.org/10.36348/jaspe.2025.v08i05.002 | **Received:** 29.04.2025 | **Accepted:** 03.06.2025 | **Published:** 13.06.2025

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Abstract

Background: This study aimed to examine the relationships between anthropometric characteristics and physical fitness performance among adolescent male football academy players in Bayelsa State, Nigeria. Understanding these associations could inform player development and training strategies in youth football. ***Methods***: A cross-sectional analytical design was used to assess 20 male football players aged 15–25 years. Anthropometric variables measured included height (170.62 ± 3.16 cm), weight (62.95 ± 1.92 kg), waist-hip ratio (0.83 ± 0.01), body fat (%), and limb lengths. Fitness attributes evaluated were speed (40-m sprint), agility (Illinois agility test), endurance (Yo-Yo test), flexibility (sit-and-reach), core strength (plank test), and power (standing long jump). VO_{2max} was estimated using the Siri equation, with Body Density derived from the Jackson and Pollock 3-site formula. ***Results***: The players demonstrated moderate agility (17.87 ± 0.20 sec), sprint speed (5.71 ± 0.06 sec), and VO_{2max} (35.25 ± 6.12 mL/kg/min). Notably, goalkeepers' height and VO_{2max} were perfectly correlated (r = 1.000, p = 0.008), and lower limb length significantly correlated with VO_{2max} (r = 1.000, p = 0.030). Midfielders' lower limb length strongly predicted sprint speed (r = 0.886, p = 0.019). Other correlations across positions were weak or not statistically significant. ***Conclusion***: Anthropometric traits, particularly limb lengths and height, significantly influence select aspects of physical fitness in football players, varying by playing position. These findings support tailored conditioning programs based on player morphology.

Keywords: Anthropometry, Physical fitness, Football academy, VO_{2max}, Limb length, Playing position, Bayelsa State, Football.

1. INTRODUCTION

Football demands a unique combination of speed, agility, endurance, power, and flexibility, all of which are influenced by players' anthropometric characteristics (Slimani *et al.*, 2019). Height, weight, limb lengths, and body circumferences have been shown to correlate with on-field performance: taller players often demonstrate superior reach and aerial ability, while greater lean mass underpins explosive power and endurance (Norton & Olds, 2000; Williams *et al.*, 2003). For instance, lower-limb length positively correlates with sprinting velocity and standing long jump distance in elite soccer cohorts (Papla *et al.*, 2022), whereas excess adiposity has been associated with poorer agility and aerobic capacity (Ivanov *et al.*, 2022).

Moreover, position-specific requirements further modulate these relationships. Defenders typically exhibit robust somatotypes and higher body mass indices suited to physical duels (Nikolaidis *et al.*, 2016), while midfielders benefit from leaner physiques and superior aerobic fitness to cover greater distances during a match (Stølen *et al.*, 2005). Forwards often combine moderate body mass with high lower-body power to execute rapid accelerations and finish scoring opportunities, whereas goalkeepers rely on exceptional reach and trunk flexibility for diving saves (Porta *et al.*, 2023).

Although global studies have profiled anthropometry and physical performance across playing positions (Krustrup *et al.*, 2003; Buchheit *et al.*, 2013), there is a paucity of context-specific research among African football academies, particularly in Nigeria. Local talent identification and development programs would benefit from empirical data on how anthropometric traits predict performance in sub-

Saharan environments (Bernal-Orozco *et al*., 2020). Conducting such studies in Nigeria, a nation with growing football infrastructure and youth academies, ensures ecological validity and supports culturally appropriate training regimens (Carling & Orhant, 2010).

In Bayelsa State, the Fezi Resort Center in Elebele Community hosts a modern football academy whose adolescent and young adult players (ages 15–25) provide an ideal cohort for examining these dynamics. Their routine engagement in structured training and competition offers a controlled setting to assess how variables such as waist-hip ratio, limb length, and body composition relate to key fitness outcomes, including sprint times, agility runs, VO_2 Max, flexibility scores, and core endurance (Kaka'an *et al*., 2022).

This study therefore employs a cross-sectional analytical design to profile the anthropometric characteristics of male academy players in Bayelsa State, measure their physical fitness through standardized field tests, and evaluate the relationships between these anthropometric parameters and fitness performance. By capturing data in a professionally regulated environment with calibrated instruments, this research aims to generate actionable insights for coaches, sports scientists, and talent scouts operating within Nigerian football academies. The objectives of the study were to:

- Describe the anthropometric characteristics (height, weight, limb lengths, circumferences) of adolescent male football academy players in Bayelsa State, Nigeria.
- Assess their physical fitness performance (speed, agility, endurance, power, flexibility) using standardized tests.
- Determine the relationships between specific anthropometric measures and fitness outcomes across all participants.
- Explore positional variations in anthropometric and fitness profiles among defenders, midfielders, forwards, and goalkeepers.
- Identify position-specific anthropometric predictors of fitness performance among professional football players in Bayelsa State.

By elucidating how body composition influences performance in a Nigerian academy setting, the findings will inform evidence-based talent identification, optimize position-specific training programs, and ultimately enhance competitive success and injury prevention in local football development pathways.

2. METHOD

2.1 Study Design

The study employed a cross-sectional analytical design to examine the relationships between anthropometric characteristics (including height, weight, limb lengths, and body circumferences) and physical fitness performance (agility, speed, endurance, flexibility, and power) among 20 adolescent male football academy players in Bayelsa State, Nigeria.

2.2 Study Area

This study was conducted at the Fezi Resort Center, located in Elebele Community within the Ogbia Local Government Area of Bayelsa State, Nigeria. The center is a fully equipped sports complex featuring a modern fitness facility with standardized instruments suitable for both anthropometric measurements and physical fitness assessments. Available equipment included stadiometers, skinfold callipers, spirometers, sit-and-reach boxes, and various performance testing devices, ensuring high precision and reliability in data collection.

The selection of this site was based on its appropriateness for conducting both static and dynamic assessments under controlled conditions, thereby minimizing environmental or logistical factors that could influence outcomes. Furthermore, the center's proximity to the participant base (academy footballers) facilitated ease of access, consistent attendance, and strict adherence to testing protocols. Conducting the research in this professionally regulated environment enhanced the validity and reproducibility of the study's measurements.

2.3 Population for the Study

The target population for this study comprised 20 active male football players enrolled in a professional football academy in Bayelsa State, Nigeria. Participants were between the ages of 15 and 25 years, a range selected to capture a developmental spectrum of fitness capabilities among adolescent and young adult athletes. These individuals were routinely engaged in structured fitness training and competitive football, providing a relevant cohort for examining the interplay between anthropometric characteristics and physical performance.

Anthropometric variables assessed included height, weight, waist-hip ratio, body mass index (BMI), and body fat percentage, while fitness performance was evaluated using standard field tests such as the 40-meter sprint, standing long jump, and Illinois agility test. Despite the small population size, the study ensured full participation and comprehensive assessment of each subject, supporting data accuracy and reducing sampling error.

2.4 Sample and Sampling Technique

Given the manageable size of the population, a purposive sampling technique was employed, allowing for the inclusion of all 20 football players who met the inclusion criteria. This non-probability method was chosen to ensure that only individuals with specific characteristics relevant to the study; namely, active involvement in professional football training, were selected. This approach enhanced the focus and practical relevance of the research, while optimizing resource use and ensuring measurement reliability.

Should stratification have been necessary, a stratified random sampling method was proposed as an alternative, dividing participants based on performance levels (e.g., high, moderate, low) or playing positions (e.g., goalkeeper, defender, midfielder, forward) to ensure balanced representation across key subgroups. This contingency approach would allow for subgroup analyses and mitigate bias due to positional or performance-based disparities.

2.5 Method of Data Collection and Instrumentation

This study employed a structured and standardized approach to data collection, integrating anthropometric measurements and fitness performance tests to investigate the relationship between body composition and physical fitness levels in professional football academy (PFA) players. The research was conducted at Fezi Resorts Center in Elebele Community, located within the Ogbia Local Government Area of Bayelsa State, Nigeria. A purposive sample of 20 professional football academy players was selected for participation based on predefined inclusion criteria.

To ensure data quality, trained personnel conducted all measurements using standardized and validated instruments. Testing protocols were based on established sports science guidelines. Measurements were taken either in the morning or evening to minimize physiological variability due to fatigue or hydration levels. Each performance test was conducted at least twice per participant, and the average of the trials was used in the final analysis. Ethical procedures were followed throughout, including obtaining informed consent from all participants and ensuring the confidentiality of personal information.

Plate 1: Picture showing the setup process

2.5.1 Anthropometric Measurements

Anthropometric data were collected following guidelines by the International Society for the Advancement of Kinanthropometry (ISAK) and related sports science standards. Height was measured using a stadiometer with participants standing barefoot, their backs straight, and heads aligned in the Frankfurt horizontal plane. Body weight was recorded using a digital weighing scale with participants wearing minimal clothing and standing barefoot.

Waist and hip circumferences were measured using a non-elastic tape while the participant stood in anatomical position. These values were used to calculate the waist-to-hip ratio by dividing waist circumference by hip circumference. Upper limb length was measured from the shoulder joint to the tip of the middle finger, while lower limb length was measured from the hip bone to the floor, with the participant standing barefoot and upright.

Body fat percentage was estimated using the skinfold thickness method. Skinfold measurements were taken at three anatomical sites: chest, abdomen, and thigh, using a skinfold caliper. These values were converted to body fat percentage using the Jackson and Pollock equation and appropriate software. For male participants, the Jackson and Pollock 3-site formula is:

$$Body\ Density = 1.10938 - 0.0008267\ (sum\ of\ skinfolds + 0.0000016\ (sum\ of\ skinfolds\ squared) - 0.0002574\ (age)$$

Once body density was calculated, the Siri equation was used to estimate body fat percentage:

$$Body\ Fat\ (\%) = \left(\frac{4.95}{Body\ Density}\right) x\ 100$$

Thigh circumference was measured at the midpoint between the knee and hip joints, and calf circumference was measured at the widest part of the calf muscle, both using a flexible measuring tape. Repeated measurements ensured consistency and minimized error.

2.5.2 Fitness Performance Tests

Fitness assessments were conducted on a football field under the supervision of sports analysts, coaches, and physical fitness experts. All participants engaged in a light warm-up routine before testing began. Each test targeted a key physical attribute relevant to football performance, and all procedures followed standardized protocols to maintain accuracy and reliability.

Agility was assessed using the Illinois Agility Test. Cones were arranged in the standard formation of the test: a rectangular area 10 meters long and 5 meters wide, with four cones placed to form the rectangle and another four cones placed in a straight line at equal distances along the centre. Each player was instructed to complete the course as quickly as possible, and their completion time was recorded using a stopwatch. The best of two trials was used for data analysis.

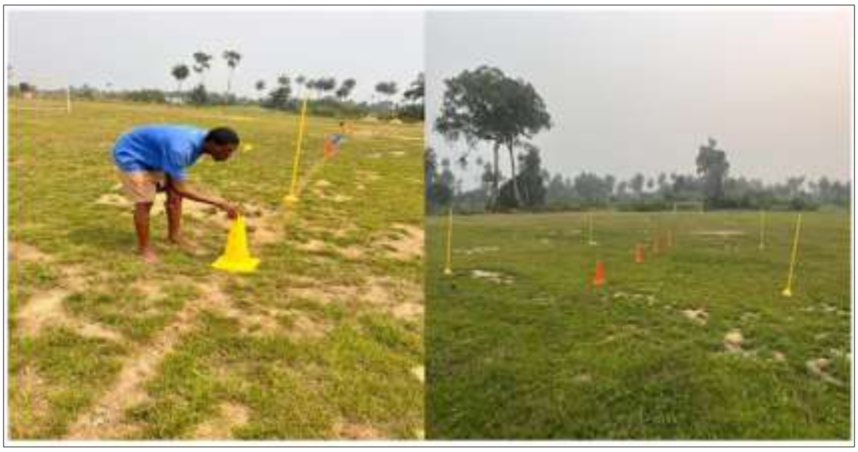

Figure 2: The setup process of the Illinois Agility Test

Speed was measured using the 40-meter sprint test. A 40-meter distance was marked using cones, and participants sprinted through the course at maximum effort. Sprint times were recorded using a stopwatch, and the fastest of two attempts was used for evaluation.

Figure 3: The 40-meter sprint setup

Endurance was assessed using the Yo-Yo Intermittent Recovery Test, commonly referred to as the beep test. Participants ran back and forth between two markers set 20 meters apart, following audio beeps that increased in frequency at each level. The total distance completed by each participant was recorded, and maximum oxygen consumption (VO_2max) was calculated using the following equation:

$$VO_{2max} = 3.46\ x\ \left(\frac{L + S}{L\ x\ 0.4325 + 7.0048}\right) + 12.2$$

In this equation, L represents the final level reached and S the number of shuttles completed at that level. The test was conducted once per player, with strict adherence to protocol to ensure internal validity.

Figure 4: Pictures showing the Beep Test setup and Players participating in the Beep Test

Flexibility was evaluated using the Sit and Reach Test. Each participant performed the test in three configurations: left leg, right leg, and both legs (trunk flexibility), using a standardized sit-and-reach box. In the trunk test, the participant sat with both legs extended and reached forward with hands stacked and palms down. In the single-leg test, one leg was extended while the other was bent, with the sole placed against the inner thigh. The best score for each configuration was recorded in centimetres. Flexibility assessments were used to determine hamstring and lower back range of motion, important for movement efficiency and injury prevention.

Figure 5: Sit and reach box for flexibility

Explosive power was assessed through the Standing Long Jump Test. Participants stood behind a start line, swung their arms, and jumped forward as far as possible. The distance from the take-off point to the back of the nearest heel at landing was measured using a measuring tape. This test served as a direct measure of lower-body power generation capacity.

Core strength was evaluated using the Plank Test, which measures muscular endurance of the abdominal and back muscles. Participants assumed a forearm plank position with elbows aligned beneath the shoulders and maintained a straight body line from head to heels. Time was recorded using a stopwatch until the participant could no longer maintain the correct posture.

The test ended when the hips dropped, the back arched excessively, or the participant voluntarily stopped. Each of these fitness assessments was carefully standardized to allow for reliable comparison and interpretation. Together, these methods provided a comprehensive dataset for examining the relationship between anthropometric characteristics and physical fitness among professional football academy players.

2.6 Data Recording and Quality Control

A structured process was employed for data recording and quality control to ensure the accuracy, reliability, and validity of anthropometric and fitness performance measurements. Standardized data sheets and digital spreadsheets were used to log each measurement immediately after testing. All measurements were taken at least twice, and the average values were recorded. Key anthropometric variables such as height, weight, arm span, leg length, BMI, body fat percentage, and waist-to-hip ratio were systematically documented. Similarly, fitness test results, including the sprint, agility, beep, plank, sit-and-reach, and standing long jump tests, were entered into the dataset in real time. To maintain data integrity, all assessments followed internationally recognized guidelines, such as ISAK for anthropometry and FIFA-endorsed fitness testing protocols. Equipment including stadiometers, weighing scales, calipers, and stopwatches was calibrated before each session. These quality control measures ensured consistent and valid data for analyzing the relationship between anthropometric traits and fitness performance in professional football academy players.

2.7 Methods of Data Analysis

Data analysis was aimed at identifying patterns, relationships, and statistical significance among the measured anthropometric and fitness variables. Raw data were entered into IBM SPSS. Descriptive statistics, including means, standard deviations, ranges, and frequency distributions, were computed to summarize the dataset. Inferential statistics such as Pearson's correlation, linear regression, independent samples t-tests, and one-way ANOVA were employed to evaluate associations between anthropometric characteristics and fitness performance outcomes. Statistical significance was set at $p < 0.05$.

2.8 Ethical Considerations

This study adhered strictly to ethical standards to protect the rights, welfare, and privacy of participants. Informed consent was obtained from all football players after clearly explaining the study's objectives, procedures, and potential risks and benefits. Participation was entirely voluntary, with players free to withdraw at any time without consequence, despite the use of total population sampling. To maintain confidentiality and anonymity, each participant was assigned a unique identification number, and all data were securely stored in encrypted formats accessible only to authorized personnel. All fitness assessments were conducted under professional supervision to ensure safety, with appropriate medical support and rest provided throughout. The research team upheld data integrity by transparently reporting all findings and deviations, and ensured fairness by treating all participants equally. Ethical approval was obtained from the Bayelsa Medical University Research Ethics Committee prior to the commencement of the study.

3. RESULTS

Anthropometric and Physical Fitness Characteristics of Players

The anthropometric profile of the football players (n=20) is presented in Table 1. The mean age of the players was 18.25 ± 0.49 years, indicating a relatively young cohort with low variation (SD = 2.17). The average body weight was 62.95 ± 1.92 kg, while the mean height was 170.62 ± 3.16 cm, reflecting moderate stature across the group. Upper and lower limb lengths were 62.88 ± 0.96 cm and 94.90 ± 4.58 cm, respectively, suggesting well-proportioned limb development. The mean hip-to-waist ratio was 0.83 ± 0.01, indicative of healthy fat distribution. Thigh and calf circumferences were 52.77 ± 1.32 cm and 34.64 ± 0.52 cm, respectively, reflecting a moderate level of muscular development in the lower extremities.

In terms of fitness characteristics (as shown in Table 2), the mean time for the Illinois Agility Test was 17.87 ± 0.20 seconds, suggesting average agility levels for the age group. The average 40-meter sprint time was 5.71 ± 0.06 seconds, indicating moderate sprinting capability. Flexibility was assessed for both lower limbs and the trunk, with mean values of 24.60 ± 1.36 cm for the left leg, 25.70 ± 1.38 cm for the right leg, and 26.45 ± 1.61 cm for the trunk, showing a generally balanced range of motion. The standing long jump, a proxy for lower limb explosive power, had a mean distance of 247.98 ± 3.93 cm, suggesting good muscular power among the players. Finally, the average duration for the plank test was 111.80 ± 15.14 seconds, indicating a fair level of core muscular endurance, albeit with a relatively high standard deviation (SD = 67.71), reflecting notable variation among the participants.

Table 1: Anthropometric characteristics of players (n=20)

Anthropometric parameters	Mean	Standard error of mean (SEM)	Standard Deviation of Mean
Age (years)	18.25	0.49	2.17
Weight (kg)	62.95	1.92	8.60
Height (cm)	170.62	3.16	14.15
Upper limb length (cm)	62.88	0.96	4.27

Lower limb length (cm)	94.90	4.58	20.49
Hip-waist ratio (cm)	0.83	0.01	0.03
Thigh circumference (cm)	52.77	1.32	5.89
Calf (cm)	34.64	0.52	2.31

Table 2: Fitness characteristics of players (n=20)

Fitness parameter	Mean	Standard Error of Mean (SEM)	Standard Deviation
Illinois Agiity Run (sec)	17.87	0.20	0.90
40 Meters Run (sec)	5.71	0.06	0.29
Left leg(cm)	24.60	1.36	6.07
Right leg(cm)	25.70	1.38	6.16
Trunk (cm)	26.45	1.61	7.18
Standing long jump (cm)	247.98	3.93	17.55
Plank test (sec)	111.80	15.14	67.71

Relationship between Physical Fitness Characteristics and Playing Positions

As shown in Table 3, analysis of the physical fitness characteristics across different playing positions (defenders, forwards, midfielders, and goalkeepers) revealed no statistically significant differences ($p > 0.05$) in any of the measured variables. The 40-meter sprint time, a measure of speed, showed comparable results across positions, with goalkeepers slightly slower (5.85 ± 0.03 sec) and defenders the fastest (5.63 ± 0.14 sec), though the variation was not statistically significant ($p = 0.778$). VO_2 max, indicating aerobic endurance, ranged from 32.55 ± 3.40 mL/kg/min among forwards to 37.11 ± 8.33 mL/kg/min in goalkeepers ($p = 0.740$).

Flexibility, measured at the left leg, right leg, and trunk, also showed no significant positional differences (p-values = 0.502, 0.439, and 0.675 respectively). Although goalkeepers exhibited the highest flexibility scores across all these measures, the variation did not reach statistical significance. Similarly, explosive power (standing long jump) and core muscular endurance (plank test) were not significantly different among player roles. Midfielders had the highest average plank duration (164.67 ± 98.68 sec), while goalkeepers showed the shortest (70.67 ± 20.55 sec), yet this difference was not statistically significant ($p = 0.124$).

Table 3: Relationship between physical fitness characteristics of participants and their playing positions

Variables	Defenders (n = 7)	Forwards (n = 4)	Midfielders (n = 6)	Goalkeepers (n = 3)	P-value	Inference
40 Meters Run (sec)	5.63 ± 0.14	5.71 ± 0.30	5.72 ± 0.46	5.85 ± 0.03	0.778	Not significant
VO2 Max (mL/kg/min)	34.49 ± 4.36	32.55 ± 3.40	35.05 ± 6.00	37.11 ± 8.33	0.740	Not significant
Left Leg (cm)	21.93 ± 4.77	26.25 ± 7.50	25.00 ± 7.56	27.83 ± 2.75	0.502	Not significant
Right Leg (cm)	23.36 ± 6.06	27.50 ± 7.72	25.08 ± 6.30	30.00 ± 2.65	0.439	Not significant
Trunk (cm)	24.29 ± 7.57	26.50 ± 8.35	26.83 ± 7.71	30.67 ± 4.62	0.675	Not significant
Standing Long Jump (cm)	252.43 ± 17.98	238.25 ± 28.30	247.42 ± 13.17	251.67 ± 6.51	0.647	Not significant
Plank Test (sec)	89.57 ± 24.73	102.25 ± 52.35	164.67 ± 98.68	70.67 ± 20.55	0.124	Not significant

Note: Mean ± SD: Mean ± Standard Deviation, n: sample size or number of subjects. $P < 0.05$ means there is a significant association between mean values.

Relationship between Anthropometric Parameters and Fitness Performance across Playing Positions

From Tables 4 to 10, the relationship between anthropometric parameters and various components of physical fitness performance among football players, categorized by their playing positions, reveals notable differences in correlations and significance across metrics.

From Table 4, the relationship between height and performance outcomes was generally weak to moderate across all playing positions. For defenders, height showed a weak positive correlation with endurance ($r = 0.636$, $p = 0.125$) and flexibility of the left leg ($r = 0.485$, $p = 0.293$). Among forwards, a strong negative correlation was observed between height and VO_2 max ($r = -0.898$, $p = 0.102$), though not statistically significant. Midfielders showed a strong positive correlation between height and speed ($r = 0.738$, p =

0.094), while goalkeepers exhibited a perfect correlation with VO_2 max (r = 1.000, p = 0.008), indicating a statistically significant association. In Table 5, the pattern for height remained consistent, reaffirming the significant positive relationship between goalkeeper height and VO_2 max (r = 1.000, p = 0.008). Other correlations across playing positions remained generally weak and non-significant.

Table 6 examined the influence of upper limb length on fitness. For midfielders, upper limb length had a significant negative correlation with agility (r = -0.830, p = 0.041), suggesting that longer upper limbs may be associated with lower agility performance. Among goalkeepers, there was a strong positive correlation between upper limb length and VO_2 max (r = 0.985, p = 0.111), although this was not statistically significant.As shown in Table 7, lower limb length displayed several meaningful associations. In goalkeepers, a perfect correlation was found again between lower limb length and VO_2 max (r = 1.000, p = 0.030), indicating statistical significance. For forwards, lower limb length was significantly negatively associated with flexibility of the left leg (r = -0.976, p = 0.024). Additionally, midfielders showed a significant positive correlation between lower limb length and speed (r = 0.886, p = 0.019).

Regarding Table 8, hip-waist ratio did not present any statistically significant correlations with performance metrics across all positions. However, notable trends include a high negative correlation between hip-waist ratio and power (r = -0.894) among forwards and between hip-waist ratio and power (r = -0.973) among goalkeepers, though both were not statistically significant. In Table 9, thigh circumference was significantly associated with agility among defenders (r = 0.947, p = 0.001), indicating that larger thigh girth may positively influence agility. Midfielders showed a strong negative correlation between thigh circumference and power (r = -0.858, p = 0.029), suggesting that larger thigh size could impair power performance in this group. Finally, Table 10 revealed no statistically significant correlations for calf circumference across all positions. Nevertheless, defenders exhibited a strong negative correlation between calf size and agility (r = -0.746, p = 0.054), nearing significance, while goalkeepers showed strong positive correlations with power (r = 0.972) and negative with endurance (r = -0.978), albeit not statistically significant.

Table 4: Relationship between weight and fitness performance among individual players (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Height	r	-0.017	-0.097	0.362	0.485	0.362	0.040	0.466	0.636
		p	0.971	0.837	0.425	0.293	0.424	0.932	0.292	0.125
Forwards	Height	r	- 0.695	-0.206	-0.898	-0.407	-0.620	-0.446	0.803	-0.020
		p	0.305	0.794	0.102	0.593	0.380	0.554	0.197	0.980
Midfielders	Height	r	- 0.640	0.738	0.110	-0.073	-0.201	-0.157	- 0.551	-0.046
		p	0.171	0.094	0.835	0.891	0.703	0.767	0.257	0.931
Goalkeepers	Height	r	0.107	0.161	1.000	-0.222	0.161	0.640	- 0.739	0.721
		p	0.932	0.897	0.008	0.857	0.897	0.557	0.471	0.487

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. p<0.05 means there is significant association between mean values. n = sample size or number of subjects

Table 5: Relationship between height and fitness performance among their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Height	r	-0.017	-0.097	0.362	0.485	0.362	0.040	0.466	0.636
		p	0.971	0.837	0.425	0.293	0.424	0.932	0.292	0.125
Forwards	Height	r	- 0.695	- 0.206	-0.898	-0.407	-0.620	-0.446	0.803	-0.020
		p	0.305	0.794	0.102	0.593	0.380	0.554	0.197	0.980
Midfielders	Height	r	- 0.640	0.738	0.110	-0.073	-0.201	-0.157	- 0.551	-0.046

		p	0.171	0.094	0.835	0.891	0.703	0.767	0.257	0.931
Goal keepers	Height	r	0.107	0.161	1.000	-0.222	0.161	0.640	- 0.739	0.721
		p	0.932	0.897	0.008	0.857	0.897	0.557	0.471	0.487

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. p<0.05 means there is significant association between mean values. n = sample size or number of subjects

Table 6: Relationship between upper limb length and fitness performance within their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Upper limb length (cm)	r	- 0.024	0.082	-0.084	-0.084	0.100	-0.099	0.322	0.098
		p	0.960	0.861	0.859	0.858	0.831	0.832	0.481	0.834
Forwards	Upper limb length (cm)	r	- 0.765	- 0.261	-0.918	-0.426	-0.671	-0.459	0.870	0.097
		p	0.235	0.739	0.082	0.574	0.329	0.541	0.130	0.903
Midfielders	Upper limb length (cm)	r	- 0.830	0.379	0.659	0.530	0.429	0.422	0.003	0.146
		p	0.041	0.459	0.155	0.279	0.395	0.405	0.996	0.783
Goalkeepers	Upper limb length (cm)	r	0.266	0.000	0.985	-0.376	0.000	0.756	- 0.620	0.600
		p	0.828	1.000	0.111	0.754	1.000	0.454	0.574	0.590

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. p<0.05 means there is significant association between mean values. n = sample size or number of subjects

Table 7: Relationship between lower limb length and fitness performance within their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defender	Lower limb length (cm)	r	0.225	-0.375	0.067	-0.281	-0.331	-0.284	-0.679	-0.497
		p	0.627	0.407	0.886	0.542	0.468	0.537	0.093	0.257
Forwards	Lower limb length (cm)	r	- 0.965	- 0.772	-0.584	-0.838	-0.976	-0.847	0.786	0.513
		p	0.035	0.228	0.416	0.162	0.024	0.153	0.214	0.487
Midfielders	Lower limb length (cm)	r	- 0.689	0.886	-0.054	-0.210	-0.316	-0.353	- 0.783	-0.320
		p	0.130	0.019	0.919	0.690	0.542	0.492	0.066	0.537
Goalkeepers	Lower limb length (cm)	r	0.126	0.143	1.000	-0.240	0.143	0.655	- 0.726	0.708
		p	0.920	0.909	0.030	0.846	0.909	0.546	0.483	0.499

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. p<0.05 means there is significant association between mean values. n = sample size or number of subjects

Table 8: Relationship between hip waist ratio and fitness performance within their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Hip waist ratio	r	- 0.373	0.126	-0.337	-0.350	-0.197	-0.179	0.105	-0.153
		p	0.410	0.788	0.459	0.441	0.671	0.701	0.823	0.744
Forwards	Hip waist ratio	r	0.563	-0.079	0.894	-0.125	0.302	-0.117	- 0.894	-0.328
		p	0.437	0.921	0.106	0.875	0.698	0.883	0.106	0.672
Midfielders	Hip waist ratio	r	0.201	- 0.319	-0.104	0.017	0.041	0.061	0.675	-0.231
		p	0.702	0.537	0.845	0.974	0.939	0.909	0.141	0.660
Goalkeepers	Hip waist ratio	r	- 0.387	0.619	0.881	0.277	0.619	0.189	- 0.973	0.966
		p	0.747	0.575	0.314	0.821	0.575	0.879	0.149	0.166

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. $p<0.05$ means there is significant association between mean values. n = sample size or number of subjects

Table 9: Relationship between thigh circumference and fitness performance within their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Thigh circumference (cm)	r	0.947	0.483	-0.296	-0.444	-0.662	-0.486	- 0.692	0.542
		p	0.001	0.272	0.519	0.318	0.105	0.269	0.085	0.209
Forwards	Thigh circumference (cm)	r	0.008	0.649	-0.789	0.520	0.230	0.484	0.485	-0.421
		p	0.992	0.351	0.211	0.480	0.770	0.516	0.535	0.579
Midfielders	Thigh circumference (cm)	r	- 0.723	0.641	-0.089	-0.066	-0.195	-0.279	- 0.858	-0.553
		p	0.104	0.170	0.867	0.901	0.712	0.592	0.029	0.255
Goalkeepers	Thigh circumference (cm)	r	0.302	-0.545	-0.920	-0.199	-0.545	-0.277	0.948	-0.939
		p	0.805	0.633	0.256	0.879	0.633	0.821	0.207	0.224

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. $p<0.05$ means there is significant association between mean values. n = sample size or number of subjects

Table 10: Relationship between calf and fitness performance within their playing positions (n = 20)

Football Players	Anthropometric Parameter	Pearson Correlation (r)	Agility (Illinois Agility Test)	Speed (40m Sprint Test)	Beep Test (VO_2 Max, mL/kg/min)	Flexibility (Left Leg, cm)	Flexibility (Right Leg, cm)	Flexibility (Trunk, cm)	Power (Standing Long Jump, cm)	Endurance (Plank Test, secs)
Defenders	Calf (cm)	r	- 0.746	- 0.066	-0.025	0.051	0.351	0.278	0.599	-0.514
		p	0.054	0.888	0.957	0.914	0.440	0.545	0.156	0.238
Forwards	Calf (cm)	r	- 0.555	- 0.119	-0.819	-0.377	-0.518	-0.424	0.652	-0.218
		p	0.445	0.881	0.181	0.623	0.482	0.576	0.348	0.782
Midfielders	Calf (cm)	r	- 0.238	0.149	-0.192	-0.085	-0.209	-0.183	- 0.710	-0.243

		p	0.650	0.778	0.716	0.873	0.691	0.729	0.114	0.643
Goalkeepers	Calf (cm)	r	0.763	- 0.908	-0.570	-0.683	-0.908	0.277	0.972	-0.978
		p	0.447	0.275	0.614	0.521	0.275	0.821	0.151	0.134

Values are presented as Mean ± SEM. r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. $p<0.05$ means there is significant association between mean values. n = sample size or number of subjects

Predictors of Fitness Performance among Football Players

As shown in Table 11, several anthropometric parameters significantly predicted specific fitness performance outcomes among professional football players in Bayelsa State, with notable variations across playing positions.

Among defenders (n=7), thigh circumference exhibited a very strong and statistically significant positive correlation with agility performance, measured using the Illinois Agility Test ($r = 0.947$, $r^2 = 0.897$, $p = 0.001$). This suggests that 89.7% of the variation in agility performance could be explained by thigh circumference, with a prediction equation of $Y = 0.14x + 10.08$, where Y represents the agility test score and x represents thigh circumference.

For forwards (n=4), two significant predictors emerged. Firstly, lower limb length was strongly and inversely associated with agility performance ($r = -0.965$, $r^2 = 0.931$, $p = 0.035$), accounting for 93.1% of the variance in agility. The regression model, $Y = -0.15x + 32.52$, indicates that longer limbs are associated with better (i.e., lower) agility scores. Secondly, lower limb length was also negatively correlated with flexibility of the right leg ($r = -0.976$, $r^2 = 0.953$, $p = 0.024$), with the equation $Y = -1.78x + 207.06$. This result implies that as limb length increases, right leg flexibility score decreases, suggesting a trade-off between structural leverage and joint range.

In midfielders (n=6), multiple significant associations were observed. Upper limb length was negatively correlated with agility test performance ($r = -0.830$, $r^2 = 0.689$, $p = 0.041$), with the equation $Y = -0.14x + 26.49$, indicating that longer arm span may be linked to improved agility. Additionally, thigh circumference had a strong negative correlation with explosive power, as measured by the standing long jump ($r = -0.858$, $r^2 = 0.736$, $p = 0.029$), and the corresponding model $Y = -2.83x + 388.67$ suggests that increased thigh girth may be linked to reduced jump distance. Moreover, lower limb length was positively associated with sprint performance over 40 meters ($r = 0.886$, $r^2 = 0.784$, $p = 0.019$), with $Y = 0.07x - 0.72$, indicating that players with longer legs performed better in sprinting.

Among goalkeepers (n=3), height was perfectly and positively correlated with VO_2 Max ($r = 1.000$, $r^2 = 1.000$, $p = 0.008$), explaining 100% of the variance in aerobic capacity. The linear regression model $Y = 1.42x – 212.50$ indicates that taller goalkeepers demonstrated superior aerobic fitness, which may reflect a combination of biomechanical and physiological advantages in this position.

Table 11: Predictors of fitness performance among professional football players in Bayelsa State

Football Players	Parameter	r	r2	p-value	Prediction Equation
Defenders (n=7)	Thigh circumference - Illinois agility test	0.947	0.897	0.001	Y = 0.14x + 10.08
Forwards (n=4)	Lower limb length – Illinois agility test	-0.965	0.931	0.035	Y = -0.15x + 32.52
	Lower limb – Flexibility (right leg)	-0.976	0.953	0.024	Y = -1.78x + 207.06
Midfielders (n=6)	Upper limb length – Illinois agility test	-0.830	0.689	0.041	Y = -0.14x + 26.49
	Thigh circumference – Standing long jump	-0.858	0.736	0.029	Y = -2.83x + 388.67
	Lower limb length – 40 meters	0.886	0.784	0.019	Y = 0.07x -0.72
Goalkeepers (n=3)	Height – Vo2 Max	1.00	1.000	0.008	Y = 1.42x – 212.50

r: Pearson's correlation, P: statistical level of significance was determined using Pearson's correlation. $p<0.05$ means there is significant association between mean values, n: sample size. y: dependent variable, x: Independent variable.

4. DISCUSSION

This study profiled the anthropometric and physical fitness characteristics of 20 adolescent male football academy players in Bayelsa State, Nigeria. The players exhibited a mean age of 18.25 ± 0.49 years, weight of 62.95 ± 1.92 kg, and height of 170.62 ± 3.16 cm, consistent with normative values reported among elite youth footballers globally (Leko *et al.*, 2024). These values also align with prior data from Nigerian football academies, where height and weight ranges of 168–173 cm and 60–68 kg, respectively, are commonly observed.

In terms of physical performance, average times for the Illinois Agility Test (17.87 ± 0.20 sec) and 40 m sprint (5.71 ± 0.06 sec) fell within expected ranges for adolescent football players. Notably, defenders recorded the fastest sprint times (5.63 ± 0.14 sec), while goalkeepers were the slowest (5.85 ± 0.03 sec).

However, mean comparisons across positions did not yield statistically significant differences in any fitness parameter ($p > 0.05$), consistent with findings from semi-professional cohorts aged 16–22 years (Worku *et al*., 2021). Although midfielders demonstrated the highest VO_2 Max (35.05 ± 6.00 mL/kg/min), this was not significantly different from other positions, mirroring trends reported by Hammami *et al*., (2020).

Anthropometric measures demonstrated several position-specific correlations. For instance, height was a perfect predictor of VO_2 Max in goalkeepers ($r = 1.00$, $p = 0.008$), reflecting similar findings in elite European players where taller goalkeepers exhibited higher aerobic capacity (Bernal-Orozco *et al*., 2020). In defenders, thigh circumference strongly predicted agility performance ($r = 0.947$, $p = 0.001$), which supports existing evidence linking quadriceps girth to superior change-of-direction ability (Tosho, 2020).

Among midfielders, a negative correlation between upper limb length and agility ($r = –0.83$, $p = 0.041$) was observed. This is consistent with biomechanical analyses indicating that longer arms may introduce rotational inertia that slightly hampers agility (Bankole & Adefisan, 2024). Conversely, lower limb length was a strong positive predictor of sprint performance in midfielders ($r = 0.886$, $p = 0.019$), reinforcing literature that longer legs enhance stride length and sprint capacity (Casanova *et al*., 2024).

Regression analyses further identified lower limb length as a significant predictor of agility ($r^2 = 0.931$, $p = 0.035$) and right-leg flexibility ($r^2 = 0.953$, $p = 0.024$) among forwards. This suggests a biomechanical trade-off wherein greater limb leverage supports speed and range but may demand targeted flexibility training to optimize movement efficiency.

These findings reinforce the value of position-specific anthropometric profiling for performance optimization. While no significant differences in average fitness metrics were detected across positions, the presence of strong anthropometric-performance correlations within specific roles indicates that tailored conditioning programs may yield functional advantages. In resource-constrained settings, such as regional academies in Nigeria, these insights can inform cost-effective talent identification and development strategies.

This study has several strengths. It used a full set of standard anthropometric and fitness tests under controlled conditions, which improves the accuracy of the findings. By focusing on adolescent male academy players, it fills an important gap in research on youth athletes in West Africa. The position-specific analysis also provides useful insights for designing targeted training. However, the small sample size ($n = 20$) limits how widely the results can be applied, and future studies should include more participants from different locations. Because the study was cross-sectional, it cannot show how these traits change over time. Finally, since only male players were included, the results may not apply to female athletes.

5. CONCLUSIONS

This study elucidates how specific anthropometric traits, thigh circumference, limb lengths, and height, predict key fitness performances in a position-dependent manner among Nigerian academy footballers. Integrating these insights into training and scouting practices could enhance performance optimization and talent pipeline efficiency. Moreover, establishing normative anthropometric–fitness benchmarks for local academies will support evidence-based athlete development, ultimately contributing to Nigeria's competitive success on continental and global stages.

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