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Research Article

Analysis of Selected Fitness Characteristics of Kwara State League Volleyball Players in Relation to Playing Position and Sex

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Abstract:

Background: Volleyball playing positions impose different physical demands, but evidence on position-specific fitness among Nigerian sub-elite players is scarce, and many positional studies analyse male and female players together.
Aims: This study examined selected fitness characteristics of Kwara State league volleyball players in relation to playing position, while accounting for sex.
Methods: A cross-sectional ex-post facto design was used. All 55 registered league players attending the state camp (35 male, 20 female; liberos, outside hitters, opposite hitters, setters and middle blockers) were tested for combined handgrip strength, muscular endurance, leg power, agility, flexibility and body composition (body-fat percentage and muscle mass). Each variable was analysed with a 5 (position) × 2 (sex) analysis of variance (ANOVA), with partial eta squared (ηp2) as the effect size and Bonferroni-adjusted pairwise comparisons. Secondary sex-stratified one-way ANOVAs with Tukey HSD tests were treated as exploratory..
Result: Sex had large effects on handgrip strength, push-up endurance, vertical jump and agility (all $p < .001$, $\eta p2 = .31–.47$). Playing position had no significant effect on handgrip strength, push-up endurance, vertical jump, flexibility, body-fat percentage or muscle mass ($p = .195–.995$). Position affected T-test time ($F(4,45) = 5.48$, $p = .001$, $\eta p2 = .33$), with middle blockers slower than outside hitters and liberos, although this effect depended largely on three female middle blockers. In male players only, outside hitters had greater combined handgrip strength than opposite hitters (+15.1 kg) and setters (+20.1 kg).
Conclusion: At state-league level, fitness profiles were largely similar across playing positions once sex was taken into account. Conditioning programmes should be based on individual, sex-specific fitness profiles rather than on playing position alone, and larger studies are needed to confirm the male handgrip and agility differences.

Keywords: Fitness testing, Kwara State, Playing position, Sex differences, Sub-elite athletes, Volleyball

1. INTRODUCTION

Sport has captured the world's attention to an unprecedented degree, and has a much greater impact than any other industry on the economy, peace and social interaction in the world (Hayduk & Walker, 2018; World Health Organization, 2018). Performance is no longer a hobby, but a job. The Council of Europe (2021) has broadened the definition of sport to mean any form of physical activity, both informal and formal, aimed at achieving a sport result, at improving physical fitness and mental health, at fostering social integration and at building a social bond. Volleyball is played in teams of six players that have many different positions: Liberos (defensive specialists), Middle Blockers, Outside Hitter, Opposite Hitter, and Setter. It is an extremely dynamic sport where repeated sprints, jumps (blocking and spiking) and high intensity movements around the court are key to performance, and the fitness characteristics of the players play a major role in the success of the performance (Biorci et al., 2021).

Virtually all major muscle groups are used during volleyball matches. Volleyball is a power based game that demands quick and strong movements, Fatoba et al. (2023) reported, hence the muscles used in this game must be strong to produce power and flexible enough to allow effective movement. The strength of a player's leg muscles has a large impact on their capacity to execute volleyball-specific movements (Pocek et al., 2021). There is evidence that upperlimb angular velocity was good

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discriminator between successful and unsuccessful spikes at the elite level for young attackers (Sarvestan et al., 2021), while power of both upper- and lower-limb was strong predictors of selection to a junior national volleyball team (Tsoukos et al., 2019a) and upperbody strength was highly correlated with points scored in competitive matches for female athletes (Martin et al., 2024). Arm muscle is, therefore, an important indicator of the quality of a volleyball player, and spiking needs arm muscles that have the ability to produce explosive force (Marpaung & Priyonoadi, 2019). Singh and Singh (2016) also pointed out that players should have good muscular endurance as they have to bend, jump and run a lot during long matches and tournaments.

Agility is a key component of the team sport athlete and reaction time and perceptual and decision-making factors are also important for agility performance (Paul et al., 2016). For team games, agility is therefore the ability to change direction and perception/judgement. Volleyball players need to be able to quickly change direction within a small space in order to get a serve. Body composition – the proportion of muscle, fat and bone and other components of the body, which are related to fitness, is another aspect of fitness (Akindele et al., 2016). Because an adequate physique is a determinant of athletic performance, success and health, body composition should be monitored regularly in athletes (Campa et al., 2021).

In today's sporting world, competition is fierce and there's more to it than just participating and practising your skills. For most ball games, the most important characteristics of competitive success are appropriate fitness qualities and physical features (Milić et al., 2017; Toselli & Campa, 2018; Tsoukos et al., 2019b; Pocek et al., 2021). Knowing the physical requirements of a sport enables coaches and athletes to create conditioning programmes which target performance. Despite all efforts made by the athlete on training, performance could be affected by the lack of physical qualities demanded by the game; for instance, in junior volleyball, players selected by expert coaches achieved better ratings on most anthropometric and fitness tests than those who were not selected (Tsoukos et al., 2019b).

Volleyball is a high intensity, explosive sport that requires specific physical demands for each player position and requires a lot of quick explosive movement (spikes, blocks, jumps, and accelerations & decelerations). Among the specific skills, net dominant players (mostly middle blockers, opposite and outside hitters) must be tall, have long reach and high lower body power; setter must be coordinated, agile and be able to repeat jumping to sub-maximal level; liberos must be fast with high reaction and low body mass for defense (Grgantov et al., 2017; Milić et al., 2017; Toselli & Campa, 2018; Pocek et al., 2021).

Positional gradients found in elite samples. Toselli and Campa (2018) identified differences between the middle hitter/opposite position and the other positions when they studied 69 elite Italian male players; they found that players in the middle position were taller and heavier than players in other positions, and that players with bigger arm dimensions and handgrip strength were the middle hitter/opposite position players. Toselli and Campa (2018) compared the middle hitter/opposite position to the other positions in their study of 69 elite male players from Italy and found that middle hitters and opposites were taller and heavier than the other position players, and that they had larger arm dimensions and handgrip strength than the other position players; liberos had significantly lower handgrip values than the middle hitter/opposite position players. García-de-Alcaraz et al. (2020) monitored a high-level team over a complete season and reported the middle blockers had a significantly greater number of jumps than the other positions while setters had a minimal number of jumps. Tessutti et al. (2019) reported that there was a significant difference in height between liberos and the other positions (opposites, outside hitters, and middle blockers) among the young female players in Brazil. In elite male volleyball, Giannopoulos et al. (2017) found that attack ability was related to playing position, with middle blockers having higher attack ability than hitters and opposites regardless of competitive level and somatotype, while Pocek et al. (2021) determined positional differences in body height, spike jump and block jump of under-19 European female players.

Body-composition studies, grip-strength studies also supports positional specialisation. Liberos and setters in the Colombian under-23 team presented less favourable anthropometric characteristics of the upper limbs and less handgrip strength when compared to middle blockers, outside hitters, and opposites (De la Rosa et al., 2025). The middle blockers and opposites were reported to have the highest body heights, and the lowest BMI value, whereas the liberos were the lowest and highest

BMI, respectively, in a preliminary examination of the 2023 Men's African Volleyball Club Championship (Mbang Bian et al., 2024). The Ethiopian female football league has also been extended using the positional anthropometric profiling (Bekele et al., 2022). Adeoye et al. (2025) identified some anthropometric and body-composition differences within the Nigerian Premier League between the positions except arm strength. Previous studies have examined fitness levels in university and league-level volleyball players in Nigeria (Fatoba et al., 2023; Adeoye et al., 2025) but have not systematically related a wide range of fitness components to playing position and have not accounted for any differences between male and female players.

Many positional studies compare one sex, but in mixed-sex samples differences between sex may be significantly greater than differences between positions and therefore positional comparisons may be misleading if not based on sex. The present study therefore examined selected fitness characteristics of male and female Kwara State league volleyball players across the five primary positions (libero, outside hitter, opposite hitter, setter and middle blocker), accounting for sex, to provide context-specific evidence that can guide conditioning programmes in the Nigerian volleyball system and add comparative data to the global literature. The study addressed the following research questions:

1. What are the fitness characteristics (muscular strength, muscular endurance, leg power, agility, flexibility and body composition) of male and female Kwara State league volleyball players?
2. Do these fitness characteristics differ by playing position on the basis of sex?

The following null hypotheses were tested at the .05 level of significance:

H01: There is no significant difference in the fitness characteristics of Kwara State league volleyball players across playing positions, on the basis of sex.

H02: There is no significant effect of playing position on fitness characteristics between male and female players.

2. MATERIAL AND METHOD

2.1 Design and Participants

A cross-sectional ex-post facto design was used. The population comprised all registered Kwara State league volleyball players. All 55 registered players (35 male, 20 female) present at the state camp were included (total population sampling). Players were classified by their primary playing position as reported by their coaches: libero, outside hitter, opposite hitter, setter or middle blocker.

2.2 Ethical Considerations

Permission was obtained from the team managers and coaches, all participants gave written informed consent and parental/guardian consent with participant assent was obtained for players under 18 years before testing. The study was conducted in accordance with the Declaration of Helsinki.

2.3 Test Procedures

All instruments were calibrated before use. Testing was conducted in a single session in the following order: anthropometry and body composition, flexibility, handgrip strength, vertical jump, agility and muscular endurance. Participants completed a standardised 10 minutes warm-up of jogging and dynamic stretching before the performance tests. All tests followed standard protocols (American College of Sports Medicine [ACSM], 2021) and were administered by trained research assistants.

2.3.1 Anthropometry and body composition

Height was measured with a height scale to the nearest centimetre, with participants barefoot. Body mass, body-fat percentage and muscle mass (as a percentage of body mass) were measured with a bioelectrical impedance body-fat monitor (Innocare BFS8), with participants barefoot and in light clothing. BMI was calculated as body mass divided by height squared (kg/m^2).

2.3.2 Muscular strength

Handgrip strength was measured in both hands with an electronic handgrip dynamometer (Camry EH101). Participants stood with the arm by their side and squeezed maximally for about three seconds; the best of two trials for each hand was recorded in kilograms. Combined handgrip strength (the sum of the dominant and non-dominant hands) was used for analysis.

2.3.3 Muscular endurance

Muscular endurance was assessed with the push-up test, recorded as the number of correctly completed repetitions in 60 seconds.

2.3.4 Leg power

Leg power was assessed with the vertical jump test using the Sargent jump test, with standing reach subtracted from the highest point touched, following the jump. Scores were recorded in centimetres as the best of three trials.

2.3.5 Agility

Agility was assessed with the T-test (Semenick, 1990), timed with a digital stopwatch (Marathon Adanac 3000). Times were recorded to the nearest 0.1 second. The better of two trials was used.

2.3.6 Flexibility

Flexibility was assessed with the sit-and-reach test, with scores recorded in centimetres. The best of three trials was used.

2.4 Data Selection Process

Data were analysed with IBM SPSS Statistics, version 25. Descriptive statistics (mean ± standard deviation) were calculated by sex and by playing position within each sex. For each fitness variable, the primary analysis was a 5 (playing position) × 2 (sex) between-subjects analysis of variance (ANOVA) with Type III sums of squares. This tests the effect of playing position while accounting for sex, and tests whether positional differences depend on sex (the position × sex interaction). Effect sizes are reported as partial eta squared (ηp2), interpreted as small (.01), medium (.06) or large (.14) (Cohen, 1988). Where the position effect was significant, estimated marginal means for each position were compared pairwise with Bonferroni adjustment for the ten comparisons.

Because analyses combining male and female players can mask patterns specific to one sex, secondary one-way ANOVAs were conducted separately for male and female players, with Tukey HSD post hoc tests (eta squared, η^2, as the effect size). Given the small group sizes (3 to 11 players per position within sex) and the number of tests performed, these sex-stratified analyses were treated as exploratory.

Normality was examined with the Shapiro–Wilk test within each position × sex group, and homogeneity of variance with Levene's test across the ten groups. As a sensitivity analysis, Kruskal–Wallis tests were used to compare positions within each sex. Statistical significance was set at $p < .05$, and exact p values are reported.

3. RESULTS AND DISCUSSION

3.1 Results

Table 1. Characteristics of Participants by Sex

Characteristic	Male (n = 35)	Female (n = 20)	Total (n = 55)
Age group (years), n (%)			
15–18	5 (14.3)	4 (20.0)	9 (16.4)
19–22	13 (37.1)	11 (55.0)	24 (43.6)
23–2	11 (31.4)	4 (20.0)	15 (27.3)
27–30	6 (17.1)	1 (5.0)	7 (12.7)
Playing experience (years), n (%)			
1–2	8 (22.9)	11 (55.0)	19 (34.5)
3–4	10 (28.6)	7 (35.0)	17 (30.9)
5–6	11 (31.4)	1 (5.0)	12 (21.8)
7–8	2 (5.7)	1 (5.0)	3 (5.5)
Above 8	4 (11.4)	0 (0.0)	4 (7.3)
Anthropometry (mean ± SD)			
Height (cm)	179.94 ± 8.81	169.85 ± 8.81	176.27 ± 10.01
Body mass (kg)	66.41 ± 9.61	63.79 ± 9.28	65.46 ± 9.49
BMI (kg/m²)	20.56 ± 2.96	22.20 ± 3.36	21.15 ± 3.18

Table 2. Distribution of Participants by Playing Position and Sex, n (%)

Playing position	Male	Female	Total
Outside hitter	11 (31.4)	7 (35.0)	18 (32.7)
Opposite hitter	8 (22.9)	4 (20.0)	12 (21.8)
Middle blocker	7 (20.0)	3 (15.0)	10 (18.2)
Setter	4 (11.4)	3 (15.0)	7 (12.7)
Libero	5 (14.3)	3 (15.0)	8 (14.5)
Total	35 (100.0)	20 (100.0)	55 (100.0)

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Of the 55 participants, 35 (63.6%) were male and 20 (36.4%) were female. Most were aged 19–22 years (43.6%), and female players generally had less playing experience than male players (Table 1). Outside hitters were the largest positional group for both sexes (Table 2).

Table 3. Fitness Characteristics of Kwara State League Volleyball Players by Sex (Mean ± SD)

Fitness variable	Male (n = 35)	Female (n = 20)	Total (n = 55)
Handgrip strength, combined (kg)	94.07 ± 12.63	71.14 ± 16.39	85.73 ± 17.86
Push-up (repetitions)	41.37 ± 10.31	25.60 ± 7.25	35.64 ± 12.00
Vertical jump (cm)	43.15 ± 7.01	28.25 ± 7.39	37.73 ± 10.13
T-test agility (s)	8.77 ± 0.55	9.61 ± 1.06	9.08 ± 0.87
Sit-and-reach (cm)	10.14 ± 9.54	9.35 ± 7.94	9.85 ± 8.92
Body fat (%)	13.52 ± 4.53	16.72 ± 6.26	14.68 ± 5.40
Muscle mass (%)	42.57 ± 5.12	40.61 ± 4.42	41.86 ± 4.92

Table 4. Fitness Characteristics by Playing Position within Each Sex (Mean ± SD)

Variable / sex	Outside hitter	Opposite hitter	Middle blocker	Setter	Libero
Handgrip strength, combined (kg)					
Male	102.13 ± 11.80	87.05 ± 6.17	97.43 ± 10.92	82.03 ± 8.78	92.48 ± 16.09
Female	68.87 ± 16.62	68.85 ± 17.20	67.25 ± 11.07	82.50 ± 29.24	72.00 ± 7.55
Push-up (repetitions)					
Male	46.09 ± 12.83	39.25 ± 13.44	40.00 ± 4.73	34.25 ± 2.22	42.00 ± 3.74
Female	22.86 ± 7.78	27.50 ± 6.45	21.67 ± 10.02	32.00 ± 5.00	27.00 ± 3.00
Vertical jump (cm)					
Male	44.09 ± 5.24	43.50 ± 7.56	46.06 ± 8.70	36.75 ± 5.91	41.60 ± 6.95
Female	26.14 ± 4.30	27.25 ± 8.38	26.67 ± 9.45	34.00 ± 10.44	30.33 ± 9.07
T-test agility (s)					
Male	8.55 ± 0.52	8.75 ± 0.46	9.00 ± 0.58	9.25 ± 0.50	8.60 ± 0.55
Female	9.14 ± 0.69	10.00 ± 1.15	11.07 ± 0.12	9.33 ± 1.53	9.00 ± 0.00
Sit-and-reach (cm)					
Male	11.91 ± 9.26	10.88 ± 13.39	11.43 ± 10.85	5.00 ± 2.45	7.40 ± 4.04
Female	6.29 ± 7.13	10.00 ± 4.76	8.32 ± 7.58	21.33 ± 8.14	4.67 ± 2.08
Body fat (%)					
Male	12.27 ± 4.25	15.39 ± 6.24	13.53 ± 3.08	14.62 ± 3.96	12.36 ± 4.59
Female	18.60 ± 7.27	15.95 ± 4.07	21.60 ± 6.35	10.87 ± 6.21	14.36 ± 1.16
Muscle mass (%)					
Male	45.43 ± 4.17	41.24 ± 3.93	41.53 ± 5.43	42.35 ± 4.78	40.04 ± 7.38
Female	40.94 ± 4.74	38.40 ± 5.63	38.87 ± 2.35	45.17 ± 3.41	40.00 ± 2.65

Table 3 presents the fitness characteristics of the players by sex. Male players had higher mean values than female players for combined handgrip strength (94.07 vs 71.14 kg), push-up repetitions (41.37 vs 25.60) and vertical jump (43.15 vs 28.25 cm), and completed the T-test faster (8.77 vs 9.61 s). Mean sit-and-reach scores were similar for male and female players (10.14 vs 9.35 cm). Female players had a higher mean body-fat percentage (16.72 vs 13.52%) and slightly lower muscle mass (40.61 vs 42.57%). Table 4 presents the same variables by playing position within each sex.

Table 5. Two-Way ANOVA (Playing Position × Sex) of Fitness Characteristics

Fitness variable	Source	Sum of squares	df	Mean square	F	p	η_p^2
Handgrip strength, combined (kg)	Position	375.78	4	93.94	0.51	.727	.04
	Sex	4691.94	1	4691.94	25.58	< .001	.36
	Position × Sex	1576.00	4	394.00	2.15	.090	.16
	Error	8255.25	45	183.45			
Push-up (repetitions)	Position	84.51	4	21.13	0.25	.911	.02
	Sex	2261.84	1	2261.84	26.30	< .001	.37
	Position × Sex	609.36	4	152.34	1.77	.151	.14
	Error	3869.68	45	85.99			

Vertical jump (cm)	Position	10.58	4	2.65	0.05	.995	.01
	Sex	2075.95	1	2075.95	40.43	< .001	.47
	Position × Sex	364.57	4	91.14	1.78	.150	.14
	Error	2310.34	45	51.34			
T-test agility (s)	Position	9.60	4	2.40	5.48	.001	.33
	Sex	8.80	1	8.80	20.06	< .001	.31
	Position × Sex	5.20	4	1.30	2.97	.029	.21
	Error	19.73	45	0.44			
Sit-and-reach (cm)	Position	195.07	4	48.77	0.62	.649	.05
	Sex	7.24	1	7.24	0.09	.763	.00
	Position × Sex	620.97	4	155.24	1.98	.114	.15
	Error	3530.39	45	78.45			
Body fat (%)	Position	116.89	4	29.22	1.13	.357	.09
	Sex	79.18	1	79.18	3.05	.088	.06
	Position × Sex	195.47	4	48.87	1.88	.130	.14
	Error	1168.73	45	25.97			
Muscle mass (%)	Position	144.01	4	36.00	1.58	.195	.12
	Sex	23.59	1	23.59	1.04	.314	.02
	Position × Sex	75.74	4	18.94	0.83	.512	.07
	Error	1023.89	45	22.75			

Most position × sex groups met the normality assumption, except for T-test times, which were recorded to the nearest s 0.1 second and therefore took few distinct values (non-normal in seven of ten groups), and isolated groups for push-up and sit-and-reach. Levene's test indicated unequal variances for combined handgrip strength ($F(9,45) = 2.49$, $p = .021$) and T-test time ($F(9,45) = 4.52$, $p < .001$), but not for the other variables ($p = .115$–$.641$). Results for these two variables were therefore checked against the non-parametric sensitivity analyses.

Table 5 presents the two-way ANOVA results. Sex had a significant, large effect on combined handgrip strength ($F(1,45) = 25.58$, $p < .001$, $\eta_p^2 = .36$), push-up repetitions ($F(1,45) = 26.30$, $p < .001$, $\eta_p^2 = .37$), vertical jump ($F(1,45) = 40.43$, $p < .001$, $\eta_p^2 = .47$) and T-test time ($F(1,45) = 20.06$, $p < .001$, $\eta_p^2 = .31$), but not on sit-and-reach ($p = .763$), body-fat percentage ($p = .088$) or muscle mass ($p = .314$).

After accounting for sex, playing position had no significant effect on combined handgrip strength ($F(4,45) = 0.51$, $p = .727$, $\eta_p^2 = .04$), push-up repetitions ($F(4,45) = 0.25$, $p = .911$, $\eta_p^2 = .02$), vertical jump ($F(4,45) = 0.05$, $p = .995$, $\eta_p^2 = .01$), sit-and-reach ($F(4,45) = 0.62$, $p = .649$, $\eta_p^2 = .05$), body-fat percentage ($F(4,45) = 1.13$, $p = .357$, $\eta_p^2 = .09$) or muscle mass ($F(4,45) = 1.58$, $p = .195$, $\eta_p^2 = .12$). Playing position had a significant effect on T-test time ($F(4,45) = 5.48$, $p = .001$, $\eta_p^2 = .33$), and the position × sex interaction was also significant for this variable ($F(4,45) = 2.97$, $p = .029$, $\eta_p^2 = .21$). Bonferroni-adjusted comparisons showed that middle blockers were slower than outside hitters (mean difference 1.19 s, 95% CI 0.37 to 2.01, $p = .001$) and liberos (1.23 s, 95% CI 0.25 to 2.22, $p = .006$) (Table 7). The interaction was not significant for any other variable ($p = .090$–$.512$). H01 was therefore retained for six of the seven variables and rejected for agility, and H02 was retained for all variables except agility.

Table 6. Sex-Stratified One-Way ANOVA of Fitness Characteristics by Playing Position

Fitness variable	Male F(4,30)	Male p	Male η²	Female F(4,15)	Female p	Female η²
Handgrip strength, combined (kg)	3.67	.015	.33	0.40	.806	.10
Push-up (repetitions)	1.20	.330	.14	1.20	.351	.24
Vertical jump (cm)	1.29	.296	.15	0.66	.631	.15
T-test agility (s)	1.83	.149	.20	3.21	.043	.46
Sit-and-reach (cm)	0.50	.736	.06	3.38	.037	.47
Body fat (%)	0.66	.623	.08	1.55	.238	.29
Muscle mass (%)	1.45	.243	.16	1.25	.331	.25

In the exploratory sex-stratified analyses (Table 6), combined handgrip strength differed by position among male players ($F(4,30) = 3.67$, $p = .015$, $\eta^2 = .33$); male outside hitters had greater handgrip strength than opposite hitters (mean difference 15.08 kg, 95% CI 0.23 to 29.93, $p = .045$) and

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setters (20.10 kg, 95% CI 1.44 to 38.76, p = .030) (Table 7). The same pattern was found for dominant-hand grip strength alone (F(4,30) = 4.32, p = .007), and the Kruskal–Wallis test confirmed the male handgrip difference (p = .015). No other variable differed by position among male players (p = .149–.736). Among female players, T-test time (F(4,15) = 3.21, p = .043, η^2 = .46) and sit-and-reach (F(4,15) = 3.38, p = .037, η^2 = .47) differed by position: female middle blockers were slower than female outside hitters on the T-test, and female setters reached further than female outside hitters and liberos (Table 7). These female differences were not confirmed by Kruskal–Wallis tests (T-test p = .081; sit-and-reach p = .127), and the male T-test difference was not significant on either test (ANOVA p = .149; Kruskal–Wallis p = .182).

Table 7. Significant Pairwise Differences between Playing Positions

Analysis	Variable	Comparison	Mean difference	95% CI	p
Both sexes, adjusted for sex (Bonferroni)	T-test agility (s)	Middle blocker > Outside hitter	1.19	0.37 to 2.01	.001
Both sexes, adjusted for sex (Bonferroni)	T-test agility (s)	Middle blocker > Libero	1.23	0.25 to 2.22	.006
Males only (Tukey HSD)	Handgrip strength, combined (kg)	Outside hitter > Opposite hitter	15.08	0.23 to 29.93	.045
Males only (Tukey HSD)	Handgrip strength, combined (kg)	Outside hitter > Setter	20.10	1.44 to 38.76	.030
Females only (Tukey HSD)	T-test agility (s)	Middle blocker > Outside hitter	1.93	0.06 to 3.80	.042
Females only (Tukey HSD)	Sit-and-reach (cm)	Setter > Outside hitter	15.05	1.24 to 28.85	.030
Females only (Tukey HSD)	Sit-and-reach (cm)	Setter > Libero	16.67	0.33 to 33.00	.044

3.2 Discussions

The result of this study revealed that, after taking the sex into consideration, the playing position accounted for very little of the variance in fitness level of players of Kwara State league volleyball. Sex significantly affected handgrip strength, push up endurance, vertical jump and agility but not body-fat percentage, muscle mass or flexibility. In six of the seven fitness variables, there was no significant difference between playing position, while on the seventh (agility) the number of players was small. However, exploratory sex-stratified analyses indicated that this pattern was more evident in males, with the outside hitters being stronger in hand-grip strength than the opposite hitter and setter.

The overall lack of positional strength differences differs from studies investigating elite or selected players, which have reported position-specific handgrip strength and/or jumping ability and anthropometry (Milić et al., 2017; Toselli & Campa, 2018; Pocek et al., 2021; De la Rosa et al., 2025). It contradicts Tessutti et al. (2019) who documented that there is no difference in fitness test performance when comparing players by position among young female Brazilian volleyball players, however, it agrees with Adeoye et al. (2025), who reported no differences in arm strength for players in the Nigerian Volleyball Premier League. It seems likely that it is due to competitive level. Positional differentiation is more evident in elite samples and in players selected in competition (Tsoukos et al (2019b) and body composition is also found to vary according to the level of competition (Campa & Toselli, 2018). In a state league, a player can be assigned to a position based on how much the team needs them in that role, rather than on their physical characteristics, and teams often train as a group with a common programme, which would be expected to make positions' fitness profiles more alike regardless of what they are. The low number of players in each positional group also meant that the power of the analyses was diminished for moderate differences, so that a lack of significant differences should not be interpreted as indicating that positions are equivalent.

The magnitude of the sex differences in the strengths, endurance, power and agility are consistent with established sex differences in volleyball (Fuchs et al., 2019) and support the premise that when sex is not adjusted, comparisons of positions can be skewed. Importantly, some of this variation might be explained by position if the

percentages of male and female players vary across position groups in a one-way analysis of position ignoring sex. Analysing position and sex together, as in the present study, does not have this drawback and permits study of the interaction between position and sex.

Among male players, outside hitters had greater handgrip strength than opposite hitters and setters. This is in line with the upper-body requirement of the outside hitter, whose activity is characterized by the repetition of spiking, serving and blocking, which requires fast and well-coordinated upper-body movements to thwart the opponent's block (Marpaung & Priyonoadi, 2019; Sarvestan et al., 2021). Handgrip strength has been utilized to separate elite and sub-elite athletes in several court sports (Cronin et al., 2017), dominant hand grip strength has been found to predict selection into junior national volleyball teams (Tsoukos et al., 2019a), and hitters in Division I female collegiate volleyball demonstrated higher dominant-hand grip strength than passers and diggers (Hirsch et al., 2023). However, the finding only partially corresponds to the elite profiles. Toselli & Campa (2018) found that middle hitters and opposites, and not outside hitters, had the highest handgrip values among elite male players, while the opposites in this study were among the weakest male players. The interaction of position × sex was not statistically significant and small numbers of males were included in each group, so this male pattern is considered tentative. Only three to seven players per group for females were found and no positional differences were found in handgrip strength.

There was no difference between position in either sex for vertical jump. This is different to that reported by Pocek et al. (2021) when they found positional differences in spike and block jumps for junior female players and to the higher spike and block jump loads reported across an entire season by García-de-Alcaraz et al. (2020). This could be because of the test employed; a standing vertical jump might not be able to detect the approach type of spike and block jumps where positional specialisation is most pronounced. A cross-training of positions and small groups could also have been a factor.

In the 2-Way Analysis, playing position had a significant impact on T-Test agility with middle blockers being slower than outside hitters and Liberos. This is a likely direction because the liberos and outside hitters have the bulk of the ball-receiving and defensive responsibilities, which requires quick multi-directional jumping (Paul et al. 2016), and Paz et al. (2017) determined that hitters were quicker than setters and middle blockers in agility tests amongst young female players. The findings must be taken with a pinch of salt, however. It was largely due to the three girls middle blockers who had times around 11 s, the T test was only to the nearest 0.1 second and this decreased the level of accuracy in measuring times, the variances were unequal and the Kruskal–Wallis tests showed no positional difference for either sex. Similarly, the greater flexibility of female setters compared with female outside hitters and liberos was based on only three setters, had wide confidence intervals and was not confirmed by the non-parametric test. One or more of these differences seen in the females may have been a chance finding, given the number of exploratory comparisons that were made.

There were no differences between the positions in terms of body fat or muscle mass. This is different from the general body size and composition differences reported for liberos compared to elite African and South American net players (Mbang Bian et al., 2024; De la Rosa et al., 2025), although not dissimilar to the liberos in the present sample. In players at a younger or growing age, body composition is related to training and growth (Kutáč et al., 2020) and at the state-league level, nutritional and conditioning support may not be as extensive as in older, more mature players, which could also reduce positional differentiation. Moreover, the monitoring of hydration status with consumer bioelectrical impedance devices is less precise than laboratory-based techniques like dual-energy X-ray absorptiometry (Campa et al., 2021; Kasper et al., 2021).

The results have implications for practice. At this level of play, playing position alone appears to be a weak basis for prescribing conditioning. Coaches should instead test players periodically and use each player's own results, interpreted against sex-specific reference values, to set individual training priorities (ACSM, 2021). Plyometric training is a well-supported option for developing the jumping and agility qualities common to all positions: it improves vertical jump, strength and agility in volleyball players (Gjinovci et al., 2017; Silva et al., 2019; Ramirez-Campillo et al., 2020), is effective in amateur and professional players (Ramirez-Campillo et al., 2021) and benefits female athletes (Stojanović et al., 2017; Idrizovic et al., 2018), although individual programmes do not always produce significant jump improvements

(Mroczek et al., 2018). The male handgrip findings suggest that upper-body strength may deserve particular attention in male setters and opposite hitters, pending confirmation in larger samples..

3.3 Limitations

There are several limitations of this study. First, all available league players had been tested, but the number in each sex in the positional groups were small (three to eleven players) and so the study lacked power to demonstrate moderate positional differences and non-significant outcomes did not prove that positions were equivalent. Second, the results of sex-stratified analyses were many and numerous comparisons were made without adjustment across variables and should be viewed as exploratory. Thirdly, T-test times were only measured to the nearest 0.1 second, limiting the accuracy of the agility data. Fourth, the study was cross-sectional, was measured at one camp in one state, and only collected age in age bands and lacked sport-specific measures such as spike jump, block jump or match performance. Future studies should use larger samples, sex stratified, from a number of states in Nigeria, measure agility times to a hundredth of a second or less, incorporate approach based jump tests, adopt appropriate performance measures, and monitor players over time.

4. CONCLUSION

Based on the findings of this study, the following conclusions were drawn:

1. Male Kwara State league volleyball players had markedly greater handgrip strength, push-up endurance and vertical jump, and faster agility times, than female players, while flexibility, body-fat percentage and muscle mass were similar between the sexes.
2. Once sex was taken into account, playing position had no significant effect on handgrip strength, muscular endurance, leg power, flexibility, body-fat percentage or muscle mass.
3. Middle blockers recorded slower T-test times than outside hitters and liberos, but this finding rested largely on three female players and should be regarded as tentative.
4. Among male players, outside hitters had greater handgrip strength than opposite hitters and setters; this preliminary finding requires confirmation in larger samples.

Conditioning programmes for state-league players should be guided by regular individual, sex-specific fitness testing rather than by playing position alone.

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6. AUTHOR CONTRIBUTION STATEMENT

Conceptualisation, OF, MF; methodology, OF; formal analysis and data curation, MF; original draft preparation, OF; review and editing, MF. All authors have read and agreed to the published version of the manuscript.

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