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Original Research Article

An analysis of indices and ratios in anthropometric body measurements among team sports athletes

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ABSTRACT

Background: Physical indices and proportions based on anthropometry are crucial for determining the performance of players in team sports. The study aims to analyze the anthropometric status, body mass and shape indices, including waist-to-hip and height ratios, among athletes from different team sports.

Methods: Study involved 135 male team-sport athletes specializing in basketball, handball, and volleyball, with 45 players in each sport. Researchers collected anthropometric data, including chronological age (CA), height (Ht), weight (Wt), body mass index (BMI), waist circumferences (WC) and hip circumferences (HC), waist-hip ratio (WHR), waist-height ratio (WHtR), and a body shape index (ABSI). To compare variables across groups, descriptive statistics and one-way ANOVA with LSD post-hoc tests used. Relationships within each group were examined using correlation analysis.

Results: The ANOVA findings indicated F-values (2, 132) for CA at 0.57, p=0.57, BMI at 0.59, p=0.56, WC at 2.10, p=0.13, WHR at 1.37, p=0.27, and ABSI at 1.41, p=0.25, respectively, revealing no significant disparities among the groups. Conversely, Ht at 13.36, p=0.00, Wt at 5.74, p=0.00, HC at 6.33, p=0.00, and WHtR at 3.60, p=0.03, respectively, highlighted significant variations between the groups. Furthermore, the correlation of BMI, WC, HC, WHR, WHtR, and ABSI in each group showed a strong positive correlation (p<0.01).

Conclusions: Athletes in team sports were found to have similar body mass and shape indices, including ratios for WHR, while the WHtR ratio showed significant variations among the groups. Despite these differences, measures of athletes' health metrics across these sports remain within safe, normal ranges.

Keywords: Anthropometric status, Body index, Health metric, Measurement ratio, Team sports

INTRODUCTION

Sports performance depends on various components, such as physical body composition, exercise, and nutrition. Indexes and ratios of body factors like body mass index (BMI), a body shape index (ABSI), waist-hip ratio (WHR), and waist-height ratio (WHtR) affect the performance of team sports players. Analyzing an athlete's body composition is crucial for optimizing their health and sports performance.[1] Regular exercise maintains fitness, prevents injuries and diseases, preserves muscle and bone density, balances energy, and prevents fat accumulation.[2] However, some sports require changes in body mass and composition that might not be suitable for every athlete.[3] Sports fitness relies heavily on body composition: bulk and lean mass are essential in sports like American football and heavyweight athletics, while low body fat is beneficial in endurance sports like running and cycling. Strength-to-mass ratio is crucial in sports like gymnastics and boxing, where maintaining weight is key, especially in weight-class sports such as boxing and martial arts. In combined anaerobic and aerobic sports, such as basketball and soccer, low body fat and high lean mass are advantageous.[4] Conversely, sports that emphasize strength and power, like weightlifting, may exhibit higher BMI values due to increased muscle mass, which does not necessarily correlate with increased fat mass.[5]

The ratios of the human body provide insights into the development of individual body segments.[6] BMI, a basic height-based bodyweight index, is widely recognized as an efficient and non-invasive method to categorize individuals based on body size. It is computed as follows: kg/m^2, or weight (Wt) in kg divided by height (Ht) in meters squared. Despite its limitations, this metric is frequently employed by healthcare professionals to evaluate general health status and to identify potential health risks related to overweight or fatness.[7] BMI serves as a crucial measure for assessing health across various populations and is a vital component in maintaining a healthy lifestyle.[8] While commonly utilized by healthcare professionals, such as doctors and personal trainers, to evaluate a person's weight status, BMI may not always accurately reflect body fat levels, particularly in athletes with a muscular build. WHR, a measure of fat distribution, is computed by splitting the waist circumferences (WC) and hip circumferences (HC) together, serving as a straightforward metric to identify undesirable increases in abdominal fat.[9] This ratio is particularly significant in the context of sports and athletes, as it provides insights into the body fat distribution, a factor closely linked to both physical performance and the risk of metabolic and cardiovascular diseases.[10]

WHtR excels in pinpointing abdominal obesity and the associated health risks. It surpasses other measures in accurately detecting central fat accumulation and its related health concerns, making it a superior indicator for assessing the dangers linked to abdominal obesity.[11-13] WHtR is a more effective discriminatory tool compared to WC and BMI.[10] The ABSI is a tool employed to evaluate the threat of health problems connected to body shape, particularly obesity in the middle body.[14] It is calculated employing WC, with Wt and Ht adjustments. This index helps evaluate whether a person has a higher risk for health issues like cardiovascular disease or diabetes, based on their abdominal fat relative to their body size.[15,16] Research indicates that using BMI and ABSI together could be beneficial in clinical settings, potentially enhancing the effectiveness of health assessments in practice.[17]

This study aims to understand the anthropometric statuses, body indices, and ratios in university-level team sports athletes. Basketball, handball, and volleyball each have unique physical demands and preferred body compositions, which can significantly impact an athlete's performance. Data regarding anthropometric status, body indices, and ratios provide insights into the current physical condition of athletes, which is essential for creating specialized training and nutrition plans, improving performance, and reducing the likelihood of injuries related to sports. Additionally, understanding these differences can aid in the optimal selection and development of athletes in university sports programs, ensuring that individuals are matched with the sport best suited to their physical attributes. To achieve this, the researchers are conducting an investigation into the anthropometric statuses, body indices, and ratios of athletes in university-level team sports.

METHODS

Study design and participants

The research design was a descriptive cross-sectional study. The subject selection in this study employed purposive sampling, where 135 male university team game athletes aged 17-24 years were selected for basketball, handball, and volleyball. There were 45 players evenly distributed across each group, all of whom had participated in inter-university competitions. The research was conducted in the physical education departments of ten public universities in Bangladesh. The study period for data collection spanned two months, from January 2023 to February 2023.

The study included only participants who met specific health and physical readiness criteria, excluding individuals with acute or chronic illnesses as well as those currently experiencing physical or mental injuries. The study took steps to address ethical considerations by guaranteeing voluntary participation, respecting subjects' right to withdraw, and establishing a transparent contract between researchers and athletes.

Instruments and formulas

Anthropometric data for Ht and Wt were collected using an Indian-made digital scale from OMRON with a stadiometer made by KRUPS. The formula to determine BMI was Wt in kg divided by square of Ht in meter. Measurements for WC and HC were recorded with a CESCORF equipment’s measuring tape from Porto Alegre, Brazil. The WHR was determined by dividing the WC by the HC in centimeters. WHtR was splitting the WC by the Ht in centimeters, and ABSI was estimated using the WC (in meters), BMI, and Ht (in meters).

Here are the formulas:

$$\text{Body mass index (BMI)} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

$$\text{Waist-hip ratio (WHR)} = \frac{\text{Waist Circumference (cm)}}{\text{Hip Circumference (cm)}}$$

$$\text{Waist-height ratio (WHtR)} = \frac{\text{Waist Circumference (cm)}}{\text{Height (cm)}}$$

$$\text{A body shape index (ABSI)} = \frac{\text{Waist Circumference (m)}}{\text{BMI}^{2/3} \times \text{Height (m)}^{1/2}}$$

Measurements procedure

CA was calculated by removing the birth date from the current date. Ht was measured from the base of the top of the skull to the feet while the participants stood upright.

This was done using a KRUPS stadiometer. For accurate measurements, participants removed their shoes and any headgear. They were instructed to face forward and perch atop the stadiometer's plate with their heels touching and feet together, ensuring their back was straight and in contact with the rod. The Ht was then recorded, typically in centimeters. Wt was measured using an OMRON digital scale. Participants, sans shoes and with undergarments, stood on the center of the scale, balancing their Wt evenly on both legs while maintaining an upright posture and facing forward. The digital scale automatically displayed the player's Wt in kilograms. BMI, was utilized to assess body Wt in relation to Ht, calculated by dividing the Wt in kg by the Ht in meters square (weight (kg) / height $(m)^2$). To measure WC, participants were instructed to wear minimal clothing and stand upright with their feet close together. They located the middle distance of their bottom rib and the upper edge of their hip bone (iliac crest), typically just above the navel. A CESCORF flexible, non-stretchable tape measure was utilized. Care was taken to ensure that the tape was level with the floor and straight, not twisted. The tape was fitted around the waist comfortably, snug but not tight enough to compress the skin. Participants exhaled naturally prior to the measurement being recorded in centimeters. HC was measured by identifying the broadest part of the hips, typically around the buttocks area. Participants were advised to wear form-fitting or minimal clothing for precise measurements. They stood upright with a relaxed posture, keeping their feet close together. A CESCORF flexible, non-stretchable measuring tape was used, ensuring it remained parallel to the floor and was not twisted. The WHR was a measurement used to compare the WC by the HC together. The WHtR is a simple measure used to assess body fat distribution and its associated health risks. WHtR is determined by splitting the WC by the Ht in centimeters. The ABSI, a metric developed by Dr. Nir Krakauer, assesses the health implications of a person's body shape. ABSI is calculated using the WC (in meters), BMI, and Ht (in meters).

Statistical analysis

In this study, we employed descriptive statistics, which included mean, standard deviation, standard error, minimum, and maximum values, to summarize the dataset. We conducted a one-way ANOVA followed by LSD post-hoc analysis to compare these variables among groups. Levene's test verified equal variances, confirming a normal data distribution. We also calculated correlation coefficients to assess relationships within each group of variables. IBM SPSS version 22 for Windows was used to perform the statistical analysis, and p values less than 0.05 were used to signify statistical significance.

RESULTS

Table 1 provides descriptive statistics, focusing on variables such as CA, Ht, Wt, BMI, WC, HC, WHR, WHtR, and ABSI among athletes from three different sports: basketball, handball, and volleyball. All players, aged 18-24 years, show varied physical stats. Basketball players are generally taller (177.78 cm) and heavier (71.84 kg) compared to volleyball (Ht: 174.26 cm, Wt: 68.03 kg) and handball players (Ht: 170.44 cm, Wt: 66.41 kg). Their BMIs are fairly similar, around the 22-23 range. Handball players have the largest WC (79.44 cm), while basketball players have the largest HC (95.81 cm). WHR are comparable in basketball and volleyball (0.819 cm), slightly higher in handball (0.851 cm). The WHtR means are as follows: basketball (0.443 cm), handball (0.466 cm), and volleyball (0.430 cm), and the ABSI means are: basketball (0.074), handball (0.076), and volleyball (0.072).

Table 2 reveals that the differences observed between the groups were not statistically significant with respect to variables such as CA ($F(2, 132)=0.57$, $p=0.57$), BMI ($F(2, 132)=0.59$, $p=0.56$), WC ($F(2, 132)=2.10$, $p=0.13$), WHR ($F(2, 132)=1.37$, $p=0.27$), and ABSI ($F(2, 132)=1.41$, $p=0.25$). The analysis showed a marked distinction between the groups regarding the specified variables, namely, Ht ($F(2, 132)=13.36$, $p=0.00$), Wt ($F(2, 132)=5.74$, $p=0.00$), HC ($F(2, 132)=6.33$, $p=0.00$), and WHtR ($F(2, 132)=3.60$, $p=0.03$), respectively. The results for CA, BMI, WC, WHR, and ABSI make the argument that significant disparities among the groups are absent. Conversely, the significant results for Ht, Wt, HC, and WHtR indicate substantial differences among the groups.

The LSD post-hoc test (Table 3) showed that notable variations in Ht were observed between the groups. Players in basketball were considerably higher than those in handball ($p=0.00$) and volleyball ($p=0.01$). Compared to handball players, volleyball players were much taller ($p=0.01$). Regarding Wt, there are notable distinctions between basketball and handball athletes ($p=0.00$), basketball and volleyball players ($p=0.02$). Still, no appreciable variations were found between handball and volleyball players ($p=0.33$). Between basketball and volleyball players, there were notable variations in HC ($p=0.00$). There were no notable variations found in basketball and handball players ($p=0.07$), or handball and volleyball players ($p=0.09$). For WHtR, significant differences were found among the handball and volleyball players ($p=0.01$), and no differences were observed between basketball and handball, or basketball and volleyball players.

Table 4 shows the correlation of the variables CA, Ht, Wt, BMI, WC, HC, and WHR in basketball, handball, and volleyball. For basketball players, Ht showed a moderate positive correlation with Wt ($r=0.647^{**}$), BMI was moderately correlated with Wt ($r=0.604^{**}$), WC and HC were high positive correlated ($r=868^{**}$), and WHR correlated highly with WC ($r=0.773^{**}$), and weakly with HC ($r=0.357^{*}$). WC, HC, WHR, and WHtR show positive high to very highly correlations with each other (ranging from r=0.775** to r=0.946**), ABSI also shows strong to extremely strong positive connections with WC, HC, WHR, and WHtR (ranging from r=0.750** to r=0.916**). In the handball group, Ht and Wt were highly correlated (r=0.708**), BMI showed a positively strong correlation with Wt (r=0.774**), and WC had weak correlations with Wt (r=0.323*). WC, WHR, and WHtR show very positively high correlations with each other (r=0.931**, and r=0.982**), ABSI also shows strong to extremely strong positive connections with WC, WHR, and WHtR (r=0.943**, r=0.889**, and r=0.951**). For the volleyball group, CA had a weak positive correlation with Wt (r=0.336*) and BMI (r=0.322*). Ht and Wt were moderately correlated (r=0.587**), BMI showed a strong correlation with Wt (r=0.758**), WC and HC had a high correlation (r=0.849**), and WHR correlated highly with WC (r=0.774**) and weakly with HC (r=0.324*). WC, HC, WHR, and WHtR show positive high to very high correlations with each other (ranging from r=0.737** to r=0.931**), ABSI also shows positive moderate to high correlations with WC, HC, WHR, and WHtR (ranging from r=0.630** to r=0.804**). There was a statistically significant correlation at 0.01.

Table 1: Descriptive statistics of anthropometric variables.

Variables	Groups	N	Mean	SD	Std. error	Minimum	Maximum
CA (In years)	Basketball	45	22.04	1.21	0.18	20.00	24.00
	Handball	45	21.69	1.68	0.25	18.00	24.00
	Volleyball	45	21.82	1.85	0.28	18.00	24.00
Ht (cm)	Basketball	45	177.78	6.75	1.01	162.00	192.00
	Handball	45	170.44	6.37	0.95	156.50	184.00
	Volleyball	45	174.26	7.08	1.06	162.00	193.00
Wt (kg)	Basketball	45	71.84	6.75	1.01	58.20	85.50
	Handball	45	66.41	7.87	1.17	49.20	86.70
	Volleyball	45	68.03	8.66	1.29	51.00	86.00
BMI (kg/m^2)	Basketball	45	22.72	1.65	0.25	18.67	25.67
	Handball	45	22.82	1.92	0.29	18.56	26.67
	Volleyball	45	22.38	2.35	0.35	16.28	26.89
WC (cm)	Basketball	45	78.54	8.32	1.24	66.00	112.50
	Handball	45	79.44	16.35	2.44	66.00	178.50
	Volleyball	45	74.79	7.30	1.09	61.20	89.00
HC (cm)	Basketball	45	95.81	6.63	0.99	86.00	124.50
	Handball	45	93.41	5.97	0.89	84.00	113.50
	Volleyball	45	91.17	5.96	0.89	79.00	103.50
WHR (cm)	Basketball	45	0.819	0.05	0.01	0.73	0.94
	Handball	45	0.851	0.17	0.03	0.74	1.96
	Volleyball	45	0.819	0.04	0.01	0.73	0.94
WHtR (cm)	Basketball	45	0.443	0.05	0.008	0.36	0.64
	Handball	45	0.466	0.09	0.013	0.39	0.98
	Volleyball	45	0.430	0.05	0.007	0.34	0.54
ABSI (m)	Basketball	45	0.074	0.01	0.001	0.06	0.11
	Handball	45	0.076	0.01	0.002	0.06	0.15
	Volleyball	45	0.072	0.01	0.001	0.06	0.09

Table 2: One way ANOVA of anthropometric status, indices, and ratios in team sports

Variables	Groups	Sum of squares	Df	Mean square	F value	Sig. level
CA (In years)	Between groups	2.90	2	1.45	0.57	0.57
	Within groups	338.13	132	2.56		
Ht (cm)	Between groups	1215.05	2	607.53	13.36	0.00*
	Within groups	6001.34	132	45.47		
Wt (kg)	Between groups	699.07	2	349.54	5.74	0.00*
	Within groups	8036.25	132	60.88		
BMI (kg/m^2)	Between groups	4.68	2	2.34	0.59	0.56
	Within groups	526.43	132	3.99		
WC (cm)	Between groups	545.66	2	272.83	2.10	0.13
	Within groups	17154.54	132	129.96		
HC (cm)	Between groups	485.53	2	242.76	6.33	0.00*
	Within groups	5066.51	132	38.38		

Continued.

Variables	Groups	Sum of squares	Df	Mean square	F value	Sig. level
WHR (cm)	Between groups	0.03	2	0.02	1.37	0.27
	Within groups	1.49	132	0.01		
WHtR (cm)	Between groups	0.03	2	0.02	3.60	0.03*
	Within groups	0.54	132	0.00		
ABSI (m)	Between groups	0.00	2	0.00	1.41	0.25
	Within groups	0.02	132	0.00		

*Significant at 0.05 level

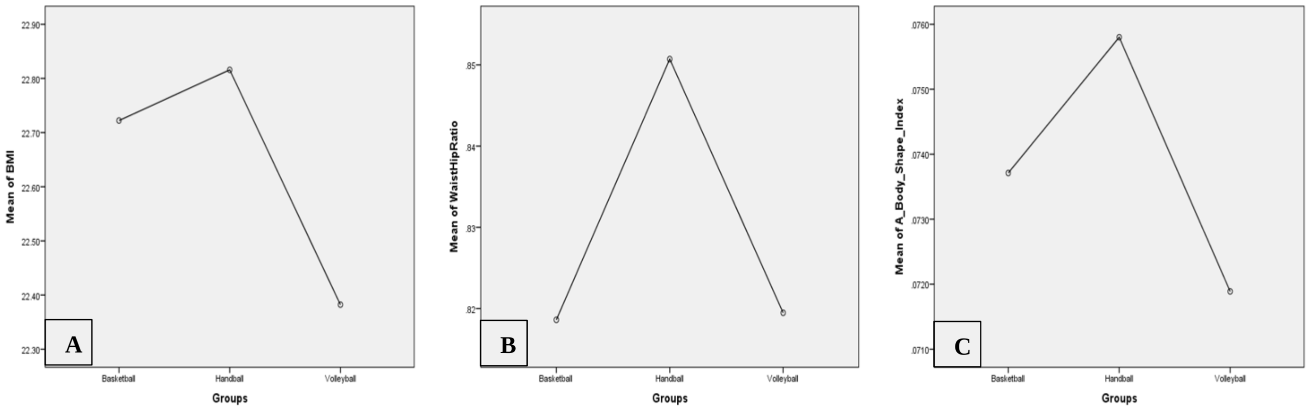

Figure 1: (A-C) Mean plots of BMI, WHR, and ABSI.

Table 3: Post hoc test (LSD).

Variables	Group	Group	Mean diff.	Std. error	Sig. level
Ht (cm)	Basketball	Handball	7.35*	1.42	0.00
		Volleyball	3.53*	1.42	0.01
	Handball	Basketball	-7.35*	1.42	0.00
		Volleyball	-3.82*	1.42	0.01
	Volleyball	Basketball	-3.53*	1.42	0.01
		Handball	3.82*	1.42	0.01
Wt (kg)	Basketball	Handball	5.43*	1.64	0.00
		Volleyball	3.81*	1.64	0.02
	Handball	Basketball	-5.43*	1.64	0.00
		Volleyball	-1.62	1.64	0.33
	Volleyball	Basketball	-3.81*	1.64	0.02
		Handball	1.62	1.64	0.33
HC (cm)	Basketball	Handball	2.40	1.31	0.07
		Volleyball	4.64*	1.31	0.00
	Handball	Basketball	-2.40	1.31	0.07
		Volleyball	2.24	1.31	0.09
	Volleyball	Basketball	-4.64*	1.31	0.00
		Handball	-2.24	1.31	0.09
WHtR (cm)	Basketball	Handball	-0.02	0.01	0.09
		Volleyball	0.01	0.01	0.35
	Handball	Basketball	0.02	0.01	0.09
		Volleyball	0.04*	0.01	0.01
	Volleyball	Basketball	-0.01	0.01	0.35
		Handball	-0.04*	0.01	0.01

*The mean difference is significant at the 0.05 level.

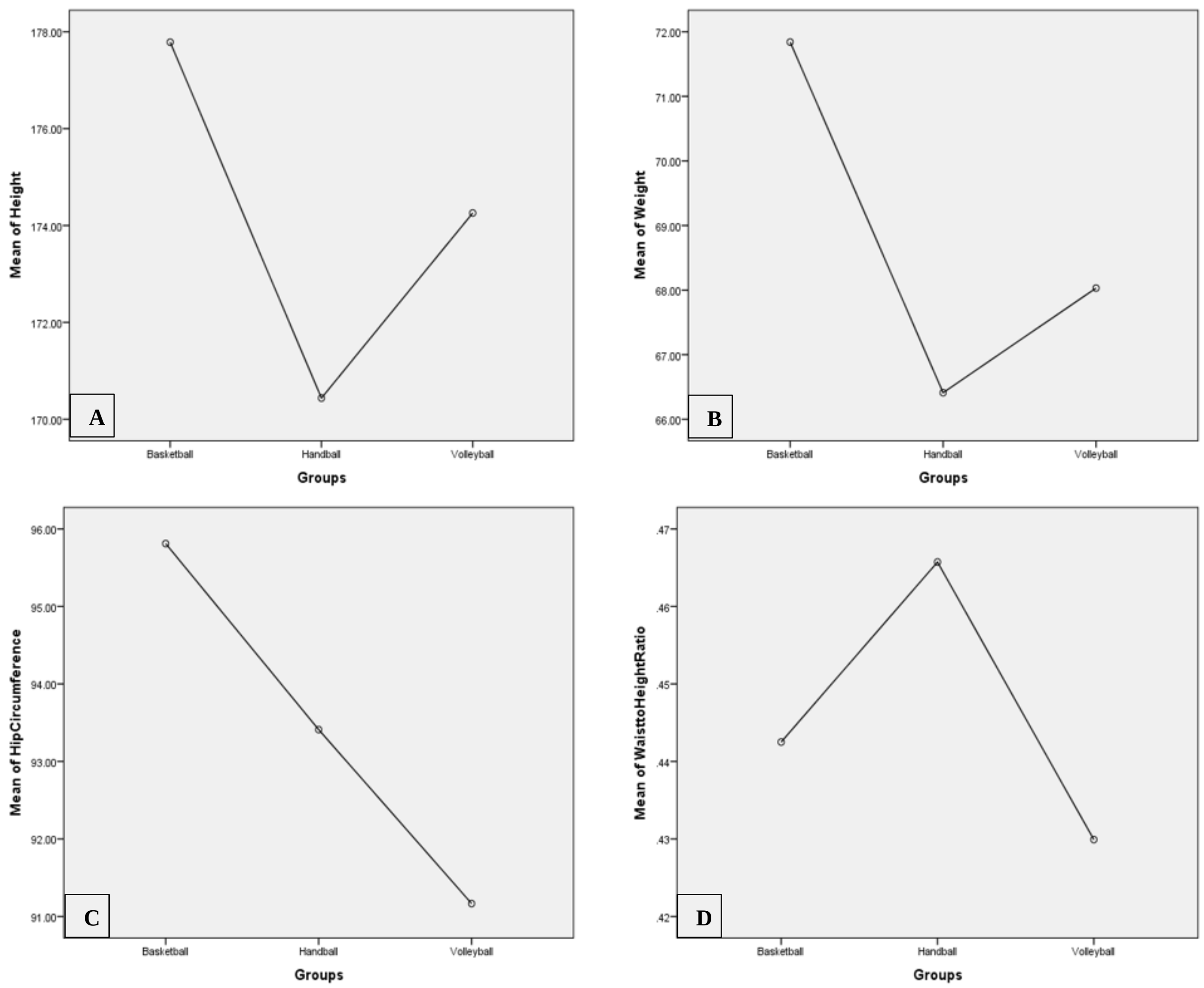

Figure 2: (A-D) Mean plots of significant variables (Ht, Wt, HC, and WHtR).

Table 4: Correlation of CA, Ht, Wt, BMI, WC, HC, WHR, WHtR, and ABSI.

Variables	R	CA (In years)	Ht (m)	Wt (kg)	BMI (kg/m^2)	WC (cm)	HC (cm)	WHR (cm)	WHtR (cm)	ABSI (m)
Basketball										
CA	r	1								
Ht	r	-0.314*	1							
Wt	r	-0.198	0.647**	1						
BMI	r	0.078	-0.214	0.604**	1					
WC	r	-0.261	-0.076	-0.177	-0.147	1				
HC	r	-0.231	0.032	-0.029	-0.061	0.868**	1			
WHR	r	-0.182	-0.191	-0.306*	-0.205	0.773**	0.357*	1		
WHtR	r	-0.138	-0.395**	-0.371*	-0.064	0.946**	0.787**	0.775**	1	
ABSI	r	-0.197	-0.134	-0.496**	-0.496**	0.916**	0.750**	0.769**	0.888**	1
Handball										
CA	r	1								
Ht	r	-0.192	1							
Wt	r	-0.037	0.708**	1						
BMI	r	0.104	0.106	0.774**	1					
WC	r	0.043	0.290	0.323*	0.163	1				
HC	r	0.082	0.128	0.128	0.060	0.278	1			
WHR	r	0.018	0.263	0.298*	0.154	0.952**	-0.030	1		
WHtR	r	0.080	0.106	0.193	0.143	0.982**	0.283	0.931**	1	
ABSI	r	0.042	0.163	0.019	-0.153	0.943**	0.287	0.889**	0.951**	1

Continued.

Variables	R	CA (In years)	Ht (m)	Wt (kg)	BMI (kg/m^2)	WC (cm)	HC (cm)	WHR (cm)	WHtR (cm)	ABSI (m)
Volleyball										
CA	r	1								
Ht	r	0.102	1							
Wt	r	0.336*	0.587**	1						
BMI	r	0.322*	-0.080	0.758**	1					
WC	r	-0.124	-0.032	-0.084	-0.072	1				
HC	r	-0.018	0.082	-0.022	-0.094	0.849**	1			
WHR	r	-0.199	-0.146	-0.119	-0.020	0.774**	0.324*	1		
WHtR	r	-0.143	-0.393**	-0.288	-0.034	0.931**	0.737**	0.780**	1	
ABSI	r	-0.306*	-0.148	-0.604**	-0.622**	0.804**	0.676**	0.630**	0.791**	1

*Correlation is significant at 0.05 level (two-tailed), **Correlation is significant at the 0.01 level (two-tailed).

Table 5: Comparison of mean indices and ratios with their standard ranges.

Variables	Groups	Mean	Standard range	Classification	Sources
BMI (kg/m^2)	Basketball	22.72	18.50-24.99	Standard range	18
	Handball	22.82	18.50-24.99		
	Volleyball	22.38	18.50-24.99		
WHR	Basketball	0.819	≥0.90 cm	Significantly increased risk	19
	Handball	0.851	≥0.90 cm		
	Volleyball	0.819	≥0.90 cm		
WHtR	Basketball	0.443	0.40-0.49 cm	No increased health risk	20
	Handball	0.466	0.40-0.49 cm		
	Volleyball	0.430	0.40-0.49 cm		
ABSI	Basketball	0.074	<0.868 m	Very low mortality risk	15
	Handball	0.076	<0.868 m		
	Volleyball	0.072	<0.868 m		

Table 5 compares mean BMI, WHR, WHtR and ABSI for athletes in basketball, handball and volleyball. These metrics are measured against value ranges and classifications, citing their sources. In BMI, all three sports groups are classified as normal weight. At WHR, each group is below the risk threshold. At WHtR, all games are in a safe range. In the ABSI, all groups showed a very low mortality risk. Overall, athletes in these sports exhibit health metrics within normal or safe values.

DISCUSSION

The results in Table 2 showed that no notable variations in body mass and shape indices, including the WC and ratio of WHR. However, significant variations were found in Ht, Wt, HC, and the ratio of WHtR among basketball, handball, and volleyball players. Previous researchers have found that basketball, handball, and volleyball, which are team-based ball sports, have several variables that are significant, while others are not.[21,22] Table 4, focusing on the relationship in three different team sports, revealed strong positive correlations among various physical measurements in each group. The data indicated a consistent pattern of significant associations between these body metrics across the different sports groups. Physical activity significantly impacts body composition and athletic performance across different sports.[23] Soccer players with a higher BMI have a lower aerobic capacity, while over 90% of elite soccer players have a normal BMI.[24,25] BMI and WHR are used to assess abdominal characteristics,[26] and excess fat in the lower limbs and abdomen negatively impacts the performance of marathon runners.[27] However, body composition, with larger sizes benefitting, varies by sport and position. Players in different sports and positions exhibit varying body variations.[28-30] Researchers suggest that these measures may not always accurately reflect an athlete's health or performance ability, especially in strength and power sports.[31]

Physical activity, particularly in sports, generally leads to lower BMIs and body fat percentages in athletes compared to inactive individuals.[32] BMI is useful for evaluating physical capabilities across different sports and performance levels.[33] Although BMI is not the sole indicator of athletic performance, it is significant in sports requiring agility, speed, and strength, like basketball, where athletes benefit from low body fat and increased lean muscle.[34] BMI showed no notable differences and significant variations were observed in body Ht and Wt, with volleyball players being notably taller than handball players.[35] However, when assessing fat levels in athletes and young adults, BMI should be used with other anthropometric measures for greater accuracy.[36] Anthropometric measurements, such as height, weight, and WHR, are crucial for evaluating health and performance in volleyball, linking them to injuries and imaging outcomes.[37] Basketball research focuses on height, body mass, and limb length, while handball study emphasized that WHR had a positive relationship with the physical fitness of male university players.[38,39] Additionally, the WHtR is the best predictor of health danger in adults, outperforming WC and BMI.[40]

In general, athletes participating in basketball, handball, and volleyball were evaluated against established norms and classifications. All three sports categories fell within the normal weight range according to their BMI. In terms of WHR, each group was found to be below the risk threshold. With regard to WHtR, athletes from all three sports were within a safe range. For ABSI, all groups demonstrated a significantly low risk of mortality. Thus, athletes in these sports demonstrate health metrics that are within normal or safe ranges.

Limitations

Limitation of the study was to increase its accuracy by including more measurements and formulas to calculate various indices and ratios for athletes. Increasing the number of team sports and expanding the sample size contributed to obtaining more accurate results.

CONCLUSION

Team sports athletes exhibited comparable body mass and shape indices, with consistent ratios in WHR. However, the WHtR ratio was the single metric displaying notable differences between the groups. Athletes from basketball, handball, and volleyball consistently maintained health metrics like BMI, WHR, WHtR, and ABSI within the normal weight and safe health thresholds. However, team sports and even specific positions within those sports require unique physical characteristics for optimal performance. It suggests the benefits of regular sports participation and intense training for both professional athletes and individuals.

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