EVALUATION OF ANTHROPOMETRIC TRAITS OF PRE-ADOLESCENT KARATE ATHLETES IN NAGPUR CITY

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KEYWORDS	ABSTRACT
Pre-adolescent athletes, karate, anthropometry, physical characteristics, height, weight, BMI, skin fold thickness, body fat percentage.	This study aims to explore the anthropometric characteristics of male and female pre-adolescent karate players in Nagpur city. Anthropometry, the measurement of the human body, plays a crucial role in understanding the physical attributes that contribute to athletic performance. The study examines key parameters such as height, weight, skin fold thicknesses and other physical traits in both male and female karate players within the pre-adolescent age group (ages 10-12 years). A total of 100 karate players (males: n-50, age-11.1±0.78 years and females: n-50, age-11.2±0.74 years) from various clubs in Nagpur were selected through purposive sampling. Data of anthropometric characteristics was collected using standard equipment and protocols. The data collected was analyzed using MS Excel to identify variations in physical characteristics. The findings of this study will contribute to a better understanding of the physical profiles of young karate practitioners, guiding coaches and trainers in designing age-appropriate training programs to enhance performance and reduce the risk of injury. The results suggest that males were marginally taller and heavier than females. Specifically, the mean height for males was 142.98 cm (SD = 6.47), with a range of 127-165 cm, while the mean height for females was 141.75 cm (SD = 6.7), ranging from 125-163 cm. In terms of weight, the mean for males was 37.39 kg (SD = 6.75), with a range of 24.95-61.78 kg, whereas the mean for females was 35.03 kg (SD = 6.2), with a range from 23.13-54.25 kg. Males also exhibited a higher mean body mass index (BMI) of 18.29 kg/m^2 (SD = 2.85), with a range of 13.77-27.09 kg/m^2, compared to females, whose mean BMI was 17.43 kg/m^2 (SD = 2.45), ranging from 14.03-24.17 kg/m^2. Additionally, a greater proportion of males were classified as thin (4%) or overweight (28%) and obese (8%) compared to females, with respective percentages of 2%, 8%, and 2%. Both males and females exhibited significantly higher shoulder widths and lower elbow breadths compared to normative standard values ($p < 0.05$). Furthermore, while both sexes had significantly lower mid-upper arm circumferences, only females demonstrated significantly lower forearm circumferences, and males had significantly higher wrist circumferences relative to the normative standards ($p<0.05$). Both groups showed significantly higher waist and ankle circumferences but significantly lower thigh and calf circumferences compared to the normative standards ($p<0.05$). Notably, females exhibited significantly lower hip circumferences compared to the normative standards ($p<0.05$). In terms of skinfold thicknesses, both males and females had significantly lower tricep, subscapular, and suprailiac skinfold measurements than the normative standards ($p < 0.05$). However, males showed significantly higher bicep skinfold thickness compared to normative values ($p < 0.05$). Additionally, males had a slightly higher body fat percentage (mean = 18.2, SD = 4.47) than females (mean = 17.35, SD = 4.96).

INTRODUCTION

Karate, a traditional martial art originating from Okinawa, Japan, is widely practiced worldwide for its physical, mental, and technical benefits (Nakayama, 2010). It demands a combination of strength, agility, coordination, flexibility, endurance, and mental discipline (Mathunjwa, 2024). Successful performance in karate depends not only on skill development but also on an athlete's physical attributes, which influence movement efficiency, speed, balance, and overall performance (Chaabene et al., 2012). These attributes are particularly crucial for pre-adolescent children (ages 10–12 years)

who are in a critical phase of growth and motor development. During this stage, rapid physiological changes occur, affecting muscle strength, body composition, and coordination, all of which contribute to athletic potential (Malina et al., 2004).

Understanding the anthropometric characteristics of young karate practitioners is essential for optimizing their training and development (Martinez-de-Quel et al., 2021). Anthropometry, the scientific study of human body measurements and proportions, provides objective data on physical traits such as height, weight, body mass index (BMI), circumferences (shoulder, waist, hip, etc.), and skinfold thicknesses (Marfell-Jones et al., 2006). It is known that these variables affect an athlete's biomechanics, power output, and endurance, which are important factors that determine karate performance (Muntian, 2013). Body composition is a variable known to be associated with athletic performance and is thus a topic of great interest to athletes and coaches (Malina, 2007).

Previous studies have examined the relationship between anthropometry and sports, however, there are no studies specifically looking at pre-adolescent Indian karate athletes. Furthermore, body composition and physical development at this age may vary between the sexes and influence training adaptations and competitive performance (Malina et al., 2004). This study explores the anthropometric profiles of young karate athletes to identify significant gender-based differences and patterns. The results may provide useful information for coaches, trainers and sports scientists in developing training programs that maximize performance by taking into account the individual and gender specific growth trends.

This research aims to set a baseline of physical characteristics of young karate athletes from Nagpur city to help the coaches and trainers create personalized training programs for male and female athletes, which will lead to enhanced performance and reduced injury risk.

1. METHODOLOGY

2.1 Sample Selection

This study was conducted in Nagpur city, India, with 100 pre-adolescent karate players selected through purposive sampling. Participants were divided into two groups - 50 male athletes (age = 11.1 ± 0.78 y) and 50 female athletes (age = 11.2 ± 0.74 y). To have a wide representation of karate playing population, the athletes were picked from different karate clubs of Nagpur. This age range of 10 to 12 years was selected because it is an important time of physical growth and motor development.

2.2 Data Collection Procedure

The anthropometric measurements were collected using standard protocols and procedures to ensure accuracy and reliability. The following physical traits were measured:

- Height: Measured using a stadiometer to the nearest 0.1 cm.
- Weight: Measured using a calibrated digital weighing scale, recorded to the nearest 0.1 kg.
- Body Mass Index (BMI): Calculated using the formula: BMI = weight (kg) / height^2 (m^2). BMI was used to assess the general body composition of the athletes.
- Body Measurements: Various body measurements were measured with a flexible measuring tape to the nearest 0.1 cm. These included shoulder width, elbow breadth, and circumferences of mid upper arm, forearm, wrist, waist, hip, thigh, calf and ankle.
- Skinfold Thickness: Skinfold thicknesses were measured at four sites (triceps, biceps, subscapular, and suprailiac) using a skinfold calliper. These measurements help estimate body fat percentage.

Each measurement was performed three times, and the mean value was taken to minimize errors.

2.3 Data Analysis

The data collected was analyzed using Microsoft Excel. Descriptive statistics (mean, standard deviation, and range) were calculated for each anthropometric variable. The results were then compared between male and female athletes to identify significant differences. Statistical significance

was tested using t-tests, with a p-value of < 0.05 considered statistically significant. The study also compared the results with normative standards for children in the same age group.

2. RESULTS & DISCUSSION

The results of the study revealed several notable gender-based differences in the anthropometric characteristics of the male and female pre-adolescent karate players. The key findings are outlined below –

3.1 Height & Weight

Table 1 provides detailed anthropometric data for male and female pre-adolescent karate players, focusing on their height and weight measurements.

Table 1 - Anthropometric Characteristics of Male and Female Pre-Adolescent Karate Players

Parameter	Male Karate Players (n=50)	Female Karate Players (n=50)
Mean Height	142.98 cm (SD = 6.47)	141.75 cm (SD = 6.70)
Height Range	127 - 165 cm	125 - 163 cm
Mean Weight	37.39 kg (SD = 6.75)	35.03 kg (SD = 6.2)
Weight Range	24.95 - 61.78 kg	23.13 - 54.25 kg

The analysis of height and weight characteristics of male and female karate players revealed notable differences and similarities. Average height of male karate players was slightly higher (142.98 ± 6.47 cm) than average height of female players (141.75 ± 6.70 cm). Both groups had similar standard deviations of height, but the mean height difference is marginal. The observed height range for male players (127 cm to 165 cm) and female players (125 cm to 163 cm) indicates that although males tend to be slightly taller, there is a wide spectrum of statures for both genders (Martinez-de-Quel, 2021). Similarly, in terms of body weight, male players (Mean - 37.39 ± 6.75 kg) tend to be heavier on average than female players (Mean - 35.03 ± 6.2 kg). This difference, though minor, aligns with general physiological trends observed in pre-adolescent children (Tingelstad et al., 2023). Additionally, male players exhibit a wider weight range (24.95 kg to 61.78 kg) compared to their female counterparts (23.13 kg to 54.25 kg), suggesting greater variability in body composition among males.
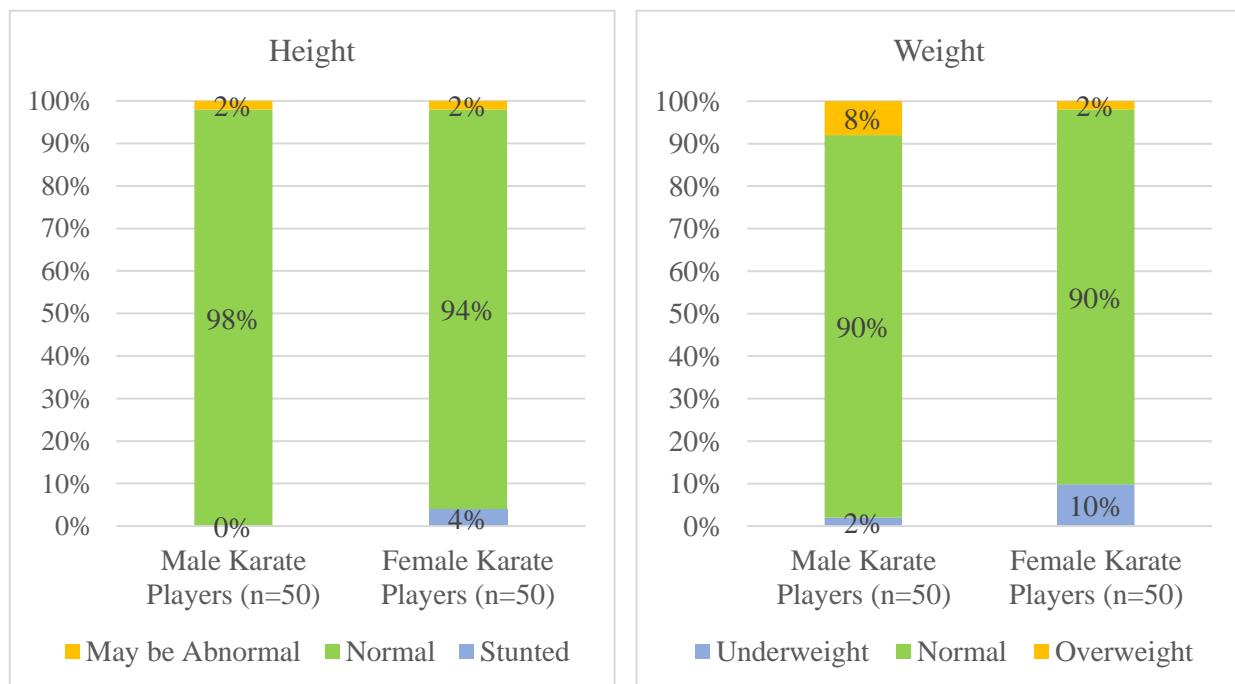

Chart 1 - Distribution of Players Above and Below Reference Standards for Height & Weight When comparing these measurements to reference standards, 98% of male players and 94% of female players fall within the normal height range. However, a small proportion of both male and

female players (2%) surpass the normal height range, whereas 4% of female players fall below the normal threshold, potentially indicating stunting (WHO, 2021). This implies that while most players have height measurements within the normal expected range, there is a subset of female players that are experiencing difficulties with growth.

With respect to weight distribution, 90% of both male and female players were within normal weight range according to reference standards, thus indicating a general compliance with expected growth patterns in this sample (Hermassi et al., 2020). However, 8% of male players and 2% of female players are classified as overweight. On the other hand, female players (10%) have a higher prevalence of underweight compared to males (2%), which may indicate nutritional or developmental differences that should be further explored (Petrie et al., 2004).

Overall, the results demonstrate that male karate players tend to have slightly higher height and weight than female karate players. Nevertheless, there is a considerable variation in these physical characteristics for both groups, which may be due to genetic factors, training regimens and differences in the development that occurs in the pre-adolescent age group (Baxter-Jones, 2019).

**2.2 Body Mass Index (BMI)**

A detailed comparison of the Body Mass Index (BMI) and male and female pre-adolescent karate players' classification is provided in Table 2.

Table 2 - Body Mass Index (BMI) and Classification of Male and Female Pre-Adolescent Karate Players

Parameter	Male Karate Players (n=50)	Female Karate Players (n=50)
Mean BMI	18.29 kg/m² (SD = 2.85)	17.43 kg/m² (SD = 2.45)
BMI Range	13.77 - 27.09 kg/m²	14.03 - 24.17 kg/m²

Results from this study show that BMI distributions of male and female pre-adolescent karate players differ significantly. The mean BMI (18.29 kg/m²) is significantly higher in male athletes than in female athletes (17.43 kg/m²) and the standard deviation (2.85 vs. 2.45) is higher. The range of BMI for male karate players (13.77 - 27.09 kg/m²) is also wider than female karate players (14.03 - 24.17 kg/m²). These results are consistent with previous research that males tend to show greater variability in physical development during pre-adolescence and suggest that there is a wider variation in body composition among male participants (Malina et al., 2004).

Chart 2 - Distribution of Players for BMI Classification
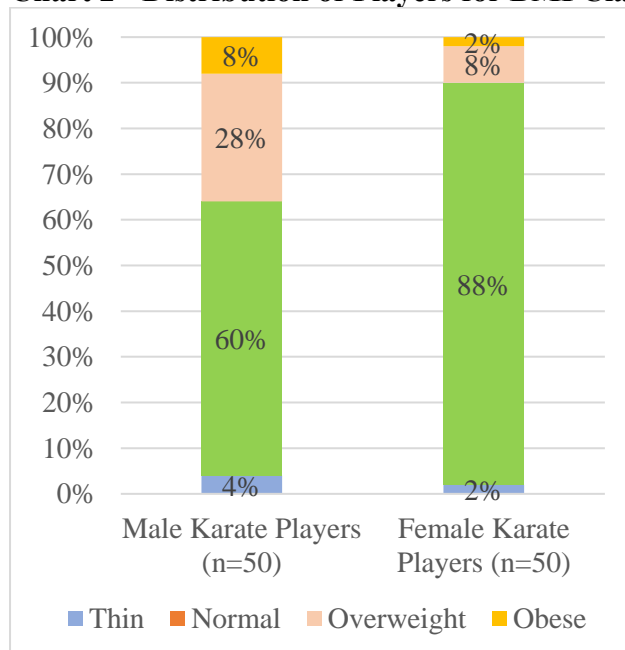
One of the main observations in this study is that the proportion of overweight and obese is greater among male karate players. Specifically, 28% of males are overweight, compared to only 8% of females, and 8% of males are classified as obese, while only 2% of females fall into this category. These trends may be influenced by differences in fat-free mass accumulation, as boys generally experience a greater increase in muscle mass due to higher levels of testosterone during growth (Beunen & Malina, 2008). In contrast, females tend to have BMI values that cluster closer to the mean, reflecting a more homogeneous distribution.

Interestingly, a higher percentage of males (4%) are classified as thin compared to females (2%). This suggests that while males exhibit a broader range of BMI values, their body compositions can vary significantly, encompassing both extremes of the BMI spectrum. (Malina et al., 2004).

### 3.3 Anthropometric Measurements
Table 3 summarizes the studied anthropometric characteristics in terms of mean, normative standards, p-values, ranges, and percentage excesses and deficits.

Table 3 - Comparison of Anthropometric Measurements Relative to Normative Standards

Parameters (cm)	Male Karate Players (n=50)					Female Karate Players (n=50)				
	Mean	Normative Standards	p-value	%Excess /Deficit	Range	Mean	Normative Standards	p-value	%Excess /Deficit	Range
Shoulder Width	36.13 ±2.65	32.50	*<0.05	11.17	30.00-43.00	37.94 ±3.02	32.7	*<0.05	16.02	31.00-48.00
Elbow Breadth	4.49 ±0.62	6.19	*<0.05	-27.46	3.00-5.50	3.88 ±0.39	5.89	*<0.05	-34.13	3.00-5.00
Mid-Upper Arm Circumference	21.45 ±3.44	24.24	*<0.05	-11.51	17.00-39.00	20.88 ±2.35	24.73	*<0.05-	-15.57	17.5-27.00
Forearm Circumference	19.95 ±2.01	20.15	>0.05	-0.99	14.00-26.00	18.72 ±1.91	19.53	*<0.05	-4.15	10.00-22.50
Wrist Circumference	14.84 ±1.57	13.73	*<0.05	8.08	12.00-21.00	13.88 ±1.13	13.73	>0.05	1.09	12.00-17.00
Waist Circumference	64.91 ±7.21	56.55	*<0.05	14.78	51.50-91.50	64.07 ±7.94	56.18	*<0.05	14.04	48.00-89.50
Hip Circumference	76.71 ±6.42	77.95	>0.05	-1.59	65.00-99.00	74.64 ±6.20	80.7	*<0.05	-7.51	64.00-91.00
Thigh Circumference	40.16 ±4.11	44.41	*<0.05	-9.57	33.00-58.00	41.34 ±5.13	45.24	*<0.05	-8.62	32.00-56.00
Calf Circumference	29.80 ±3.10	32.04	*<0.05	-6.99	24.00-39.50	28.23 ±3.01	32.95	*<0.05	-14.32	24.00-42.00
Ankle Circumference	19.71 ±1.57	18.37	*<0.05	7.29	17.00-24.00	19.11 ±1.32	18.07	*<0.05	5.76	17.00-23.00

* - indicates significant difference

Chart 3 - Distribution of Players Above and Below Normative Standards for Body Measurements
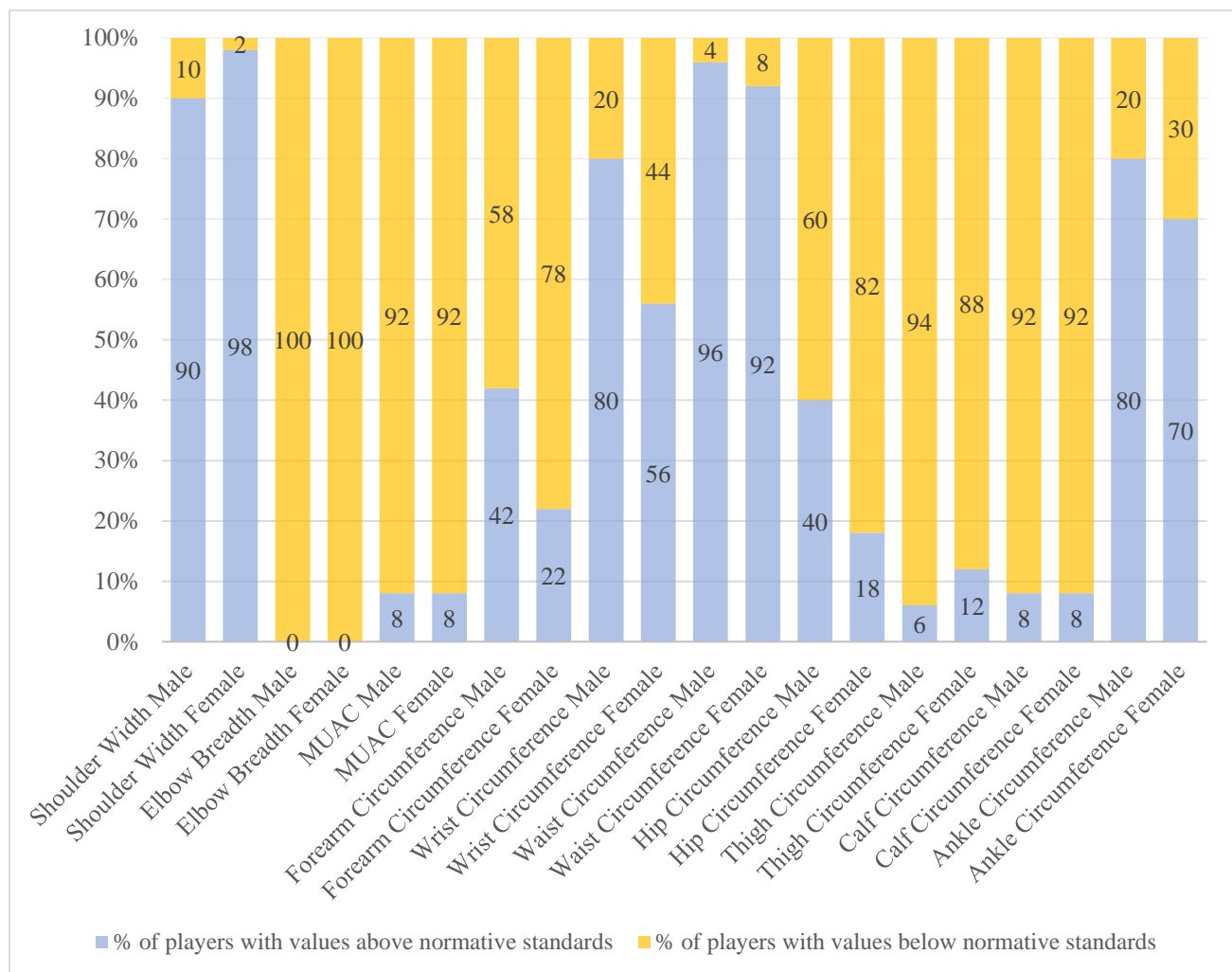
The anthropometric parameters of male and female karate players were found to be significantly deviated from normative standards, which were considered as sport-specific adaptations as well as potential effects of training regimens on body composition

Male karate players had significantly higher mean shoulder width of 36.13 ± 2.65 cm than the normative standard of 32.50 cm (p < 0.05), with 90% of participants exceeding expected values. As with female players, mean shoulder width for female players was 37.94 ± 3.02 cm, which was greater than the normative value of 32.7 cm in 98% of cases. These findings suggest that broader shoulders may be an advantageous trait in karate, potentially allowing for improved balance, increased stability and enhanced force generation during offensive and defensive striking and guarding movements (Chaabène et al., 2012). Previous studies have also supported that martial arts training enhance upper body adaptations and therefore, performance in offensive and defensive actions (Martínez-Rodríguez et al., 2023; Bovykin et al., 2023).

In contrast, elbow breadth was significantly lower than normative values in both sexes (p < 0.05). Male players had a mean of 4.49±0.62 cm (range: 3.00–5.50 cm), significantly less than the expected 6.19 cm, and 100% of participants measuring below normal. Like male players, the elbow breadth of female players was 3.88±0.39 cm (range: 3.00–5.00 cm), which was also far below the normative standard of 5.89 cm, with 100% of participants below normal. Reduced elbow breadth in both groups may be a selection or development of leaner upper extremities, which may contribute to increased speed and

precision in karate techniques. This finding is in agreement with recent literature that bone development of young athletes is highly dependent on age related skeletal growth patterns and training intensity (Vicente-Rodríguez, 2006).

Both male and female karate players had significantly lower mid-upper arm circumferences than the normative standard ($p<0.05$). Mean MUAC for males was 21.45±3.44 cm (range: 17.00–39.00 cm) compared to the normative value of 24.24 cm, and only 8% of participants exceeded and 92% were below normal. As in the case of the female athletes, a similar pattern of the mean of 20.88±2.35 cm (range: 17.5–27.00 cm) was found, which was significantly below the standard of 24.73 cm and with 92% of the players having below normal values. This indicates that the upper arm musculature is not favoured by karate training, but rather leaner arm structures for speed, agility and endurance (Chaabène et al., 2012).

However, forearm circumference showed a different pattern. Mean for males 19.95±2.01 cm (range: 14.00–26.00 cm) was not significantly different ($p>0.05$) from normative value of 20.15 cm (42% above and 58% below normal). Nevertheless, in female athletes forearm circumference was significantly lower than the normative value of 19.53 cm ($p < 0.05$) with a mean of 18.72 ± 1.91 cm (range: 10.00–22.50 cm), 22% above and 78% below normal. Given the importance of forearm strength in karate for blocking and executing strikes, the relatively preserved forearm circumference in males may be indicative of sport-specific adaptations (Martínez-Rodríguez et al., 2023; Bovykin et al., 2023)

Wrist circumference was significantly higher in male karate players compared to normative values ($p<0.05$), with a mean of 14.84±1.57 cm (range: 12.00–21.00 cm) versus the standard of 13.73 cm, and 80% of players exceeding the normative standard (Martínez-Rodríguez et al., 2023). In contrast, female karate players recorded a mean wrist circumference of 13.88±1.13 cm (range: 12.00–17.00 cm), which did not significantly differ from the normative standard of 13.73 cm ($p>0.05$), with 56% of participants above normal and 44% below, indicating that wrist morphology in female athletes may not be as distinctly adapted as in males.

Waist circumference was significantly higher in both male and female karate players than the normative standard ($p<0.05$). Males recorded a mean of 64.91±7.21 cm (range: 51.50–91.50 cm), which was substantially greater than the normative value of 56.55 cm, with 96% of participants above normal. Similarly, females had a mean waist circumference of 64.07±7.94 cm (range: 48.00–89.50 cm), exceeding the normative value of 56.18 cm, with 92% above normal. The results are in agreement with marginally with Martínez-Rodríguez et al., (2023) but the elevated waist circumference measurements of the male and female karate players should be further investigated to establish whether this is related to improved core stability, muscle hypertrophy, or other sport specific adaptations. Future studies may investigate diet, training intensity, and body composition that may show relationship with waist circumference outcomes from karate practice.

Both male and female karate players had lower hip circumference than the normative values, but the difference was not statistically significant ($p>0.05$) in males. Mean for male players was 76.71±6.42 cm (range 65.00–99.00 cm) with 40% players above and 60% players below the normative standard of 77.95 cm. Mean hip circumference was 74.64 ± 6.20 cm (range 64.00–91.00 cm) in female athletes, which was significantly lower than the normative standard of 80.7 cm ($p < 0.05$) with 18% of athletes above and 82% below the expected values. This may imply that the focus of karate training is on lower body agility and power rather than excessive hip mass. (Chaabène et al., 2012; Bovykin et al., 2023).

Study of thigh circumference revealed that males had a mean value of 40.16±4.11 cm (range: 33.00–58.00 cm), which was different from the normative value of 44.41 cm ($p<0.05$) with 6% players above and 94% players below normative values. Mean thigh circumference of female players was 41.34±5.13 cm, (range: 32.00–56.00 cm) and was significantly lower than 45.24 cm normative value, with 12% above and 88% below. These findings indicate that although strong lower body is important in karate,

the excess muscle mass may not benefit, as it is required to have high mobility and explosive movement (Bovykin et al., 2023; Martínez-Rodríguez et al., 2023)

Calf circumference was significantly lower than the normative standard of 32.04 cm for male and 32.04 cm for female athletes ($p<0.05$). Mean in male players was 29.8±3.10 cm (range: 24.00–39.50 cm) and female players had 28.23±3.01 cm mean (range: 24.00–42.00 cm) Both male and female athletes presented the same trend with 8% players having more than and 92% athletes having less than normative values. It may be that the reduced calf circumference is a preference for lean muscle development better suited for endurance and agility rather than bulk.

Lastly, ankle circumference was found to be significantly higher than normative standards in both groups ($p<0.05$). The mean recorded for males was 19.71±1.57 cm (range: 17.00–24.00 cm) and 80% were above the standard of 18.37 cm. Mean for female athletes was 19.11±1.32 cm (range: 17.00–23.00 cm), with 70% athletes exceeding the normative value of 18.07 cm. This increase may be reflective of the importance of ankle stability and strength in karate for balance, rapid directional changes, and prevention of injury (Martínez-Rodríguez et al., 2023).

In short, the anthropometric characteristics of male and female karate players were significantly different from normative values and with notable differences between the sexes. Males tended to have larger body dimensions in general than females. Below normal values for elbow breadth, mid- upper arm circumference, thigh circumference and calf circumference particularly, indicate that the sport specific adaptations favour a leaner, more agile physique. These results highlight the importance of morphotype change caused by karate training, resulting from biomechanical and physiological demands from karate sport.

3.4 Skin Fold Thicknesses

Table 4 summarizes the studied skinfold thicknesses in terms of mean, normative standards and significance of difference between them (p-value)

Table 4 - Comparison of Skinfold Thicknesses Relative to Normative Standards

Skinfold Thickness (mm)	Male Karate Players (n=50)			Female Karate Players (n=50)		
	Mean	Normative Standards	p-value	Mean	Normative Standards	p-value
Bicep	5.74±2.15	7.99	*<0.05	5.75±2.27	6.27	>0.05
Tricep	8.18±3.49	15.02	*<0.05	8.42±4.17	15.83	*<0.05
Subscapular	8.92±3.14	11.24	*<0.05	8.76±4.41	12.67	*<0.05
Suprailiac	8.74±6.41	13.15	*<0.05	9.18±5.76	14.21	*<0.05

Chart 4 - Distribution of Players Above and Below Normative Standards for Skinfold Thicknesses
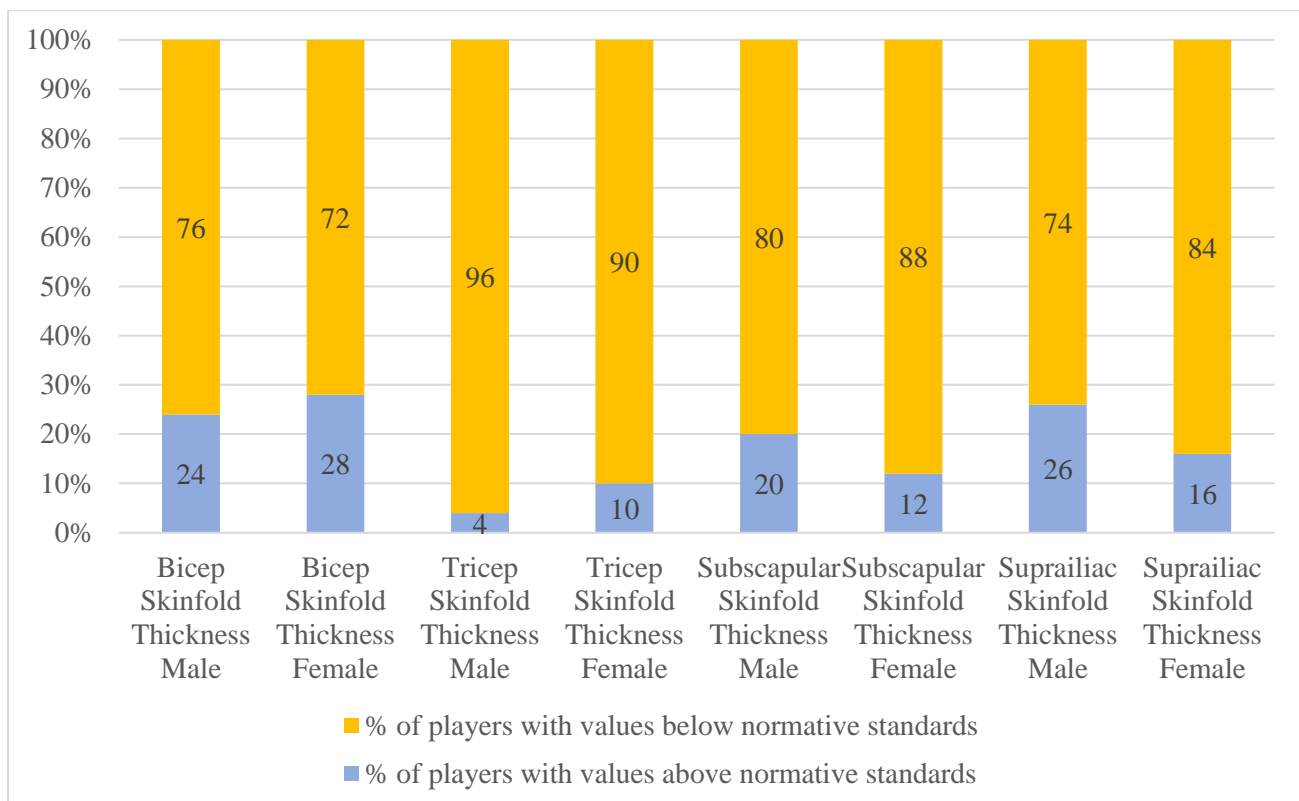
The results of this study show that male and female karate players have significantly lower adiposity levels in multiple anatomical regions than normative standards. These results were consistent with previous findings that high intensity martial arts training affects body composition (Giampietro et al. 2003; Arazi & Izadi, 2017). Dynamic movements, agility, and endurance based exercises are some of the characteristics of karate training which result in a leaner physique with less fat accumulation (Arazi & Izadi, 2017).

In comparison with the normative standard of 7.99 mm, male karate players had a significantly lower ($p<0.05$) mean bicep skinfold thickness of 5.74±2.15 mm (range 2.00–11.00 mm), with 24% having values above normal and 76% below the expected range, indicating a leaner upper-arm profile. In contrast, female karate players had a mean bicep skinfold thickness of 5.75±2.27 mm (range: 3.00–13.00 mm), which did not significantly differ from the normative standard of 6.27 mm ($p>0.05$). The proportion of female athletes with above-normal values was 28%, whereas 72% were below normal, indicating a similar trend of reduced adiposity in the upper arm, albeit with slightly more variability than males. Similar findings were reported by Martínez-Rodríguez et al., (2023).

For tricep skinfold thickness, male karate players demonstrated a mean value of 8.18±3.49 mm (range: 4.00–17.00 mm), which was significantly lower than the normative standard of 15.02 mm ($p<0.05$). A striking 96% of male players fell below the normal range, with only 4% above normal, highlighting reduced adipose tissue in the posterior upper arm. Female karate players followed a similar pattern, with a mean tricep skinfold thickness of 8.42±4.17 mm (range: 3.00–19.00 mm), which was significantly lower than the normative value of 15.83 mm ($p<0.05$). Among female players, 90% exhibited below-normal values, while only 10% had values above normal. This supports prior findings that karate training reduces adiposity, particularly in the posterior upper arm, due to the high frequency of upper-limb engagement in combat and conditioning drills (Martínez-Rodríguez et al., 2023).

Subscapular skinfold thickness, which indicates trunk fat distribution, was significantly lower than normative standards in both male and female karate players ($p<0.05$). The mean (±SD) for males was 8.92±3.14 mm (range: 5.00–20.00 mm) compared to the normative standard of 11.24 mm, with 80% of participants having below normal and 20% exceeding the expected value. Female athletes

demonstrated a similar trend, with a mean of 8.76±4.41 mm (range: 4.00–24.00 mm), significantly less than the normative standard of 12.67 mm. 88% of the participants had below normal values and 12% exceeded the standard in this group. This implies that male and female athletes have lower levels of subscapular adiposity, presumably as an adaptation to the sport's requirements for agility and endurance. In line with previous research, this argues that karate training is associated with reduced adipose accumulation in key performance-related areas (Martínez-Rodríguez et al., 2023).

Similarly, suprailiac skinfold thickness, indicative of fat deposition in the lower trunk, was significantly lower than normative standards in both male and female karate players ($p<0.05$). Mean value of 8.74±6.41 mm (range: 1.00–30.00 mm) was found in male athletes compared to normative standard of 13.15 mm, whereas female karate players showed mean value of 9.18±5.76 mm (range: 1.00–24.00 mm), which was significantly lower than normative value of 14.21 mm. A high proportion of male participants had less than expected values (74%), consistent with a trend of decreased adiposity in areas of core strength. Sumilarly, 84% of female karate athletes had values below the normative standard, and only 16% were above normal, which corroborates the fact that karate athletes present a lean body with little fat deposit in the lower trunk, which is important for core stability and for rapid directional changes (Sánchez-Puccini et al., 2014).

3.5 Body fat percentage

Body fat percentage was calculated using the skinfold thicknesses and was analyzed to assess overall adiposity levels in both groups. The mean body fat percentage of male karate players was 18.20±4.47%, with a range of 9.10 %–28.78 %. Body fat percentage of female athletes ranged from 7.42% to 28.94% with a mean of 17.35±4.96%. The values reported are lower than those reported by Hermassi et al., (2020) on the body fat percentage of handball players of the same age group. Furthermore, the values are also lower than those reported by Orntoft et al., (2018) when they studied "Physical fitness and body composition in 10–12 year old Danish children with relation to leisure time club-based sporting activities". This suggests that karate training in particular, appears to be associated with lower body fat percentage than other sports.

In summary, the skinfold thickness and body fat analysis indicate that both male and female karate players exhibit significantly lower adiposity across multiple regions, compared to normative standards Results showing reductions in bicep, tricep, subscapular and suprailiac skinfold thickness indicate a sport specific adaptation that promotes lean body composition, which is important for agility, speed and endurance in karate. Despite slight differences in the proportion of athletes having below normal values, both sexes show the same trend, indicating that karate training optimizes body composition by reducing fat and preserving functional muscle mass (Martínez-Rodríguez et al., 2023).

3. CONCLUSION

This study highlights significant anthropometric differences in pre-adolescent male and female karate players compared to normative standards. The results suggest that karate training contributes to leaner body composition, reduced skinfold thickness, and improved muscle development. However, variations between male and female participants indicate the need for gender-specific training adaptations. These findings align with recent literature on martial arts physiology, reinforcing the role of structured training in shaping young athletes' physical attributes.

However, these results must be interpreted with caution and a number of limitations should be borne in mind. This study has limitations in terms of sample size and is limited to the city of Nagpur. The use of purposive sampling may introduce selection bias and cross sectional design limits insights into developmental trends. Another limitation is the reliance on anthropometric measurements alone to assess physical fitness and athletic potential. While these parameters provide crucial information on body composition, they do not directly capture functional abilities such as agility, strength, endurance, and flexibility, which are essential for karate performance. Moreover, environmental factors such as

training intensity, coaching style, and nutritional status were not controlled, limiting the ability to attribute observed differences solely to physiological traits.

Future research should expand the sample size and include diverse populations for broader applicability. Longitudinal studies are recommended to assess developmental changes over time. Integrating biomechanical, physiological, and lifestyle assessments would enhance understanding. Future karate training programs may also be tailored to cater to gender specific growth patterns, enhancing the gender specific performance outcomes for karate.

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Conflicts of Interest
The authors declare no conflict of interest.

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Consent obtained from parent(s)/guardian(s)
Ethics approval - The study was approved by Arneja's Institutional Ethics Committee of Arneja Heart & Multispeciality Hospital, Nagpur, Maharashtra, India.

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