Anthropometric Profile, Sports Nutrition Knowledge and Its Association Among Karate Athletes in Kuantan, Pahang

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ABSTRACT

Background: Karate is a growing combat sport in Malaysia with increasing international success. Anthropometric profiles such as somatotype, body mass index (BMI), and body fat percentage influence combat performance, while sports nutrition knowledge (SNK) may further affect these factors. Therefore, this study aimed to assess the anthropometric profiles, SNK level, and its associations among karate athletes in Kuantan, Pahang. **Methods:** A total of 26 male and female karate athletes aged 14–21 years from Majlis Sukan Pahang participated in the study. BMI was calculated from height and weight, body fat percentage was estimated using two-site skinfold measurements and the Slaughter et al. equation, and somatotype was determined using the Carter and Heath method. SNK was assessed using the Nutrition Knowledge for Young Athletes (NUKYA) questionnaire. Spearman's rank-order correlation was employed to analyze associations between anthropometric profile and SNK. **Results:** Male athletes had a mean BMI of 21.3 ± 2.95 kg/m², body fat percentage of 21%, and predominantly mesomorphic somatotype. Female athletes recorded a mean BMI of 21.6 ± 0.34 kg/m², body fat percentage of 24.2 ± 3.43%, and predominantly endomorphic characteristics. Overall, athletes demonstrated low SNK, with only 11.5% scoring above 60%. No significant association was found between somatotype and SNK in either gender. However, a significant negative correlation was observed between BMI and SNK among females ($r = -0.845$, $p < 0.0001$), while a significant positive correlation was found between body fat percentage and SNK among males ($r = 0.427$, $p = 0.007$). **Conclusion:** Malaysian karate athletes in this study exhibited generally low levels of sports nutrition knowledge. While SNK showed associations with BMI (among females) and body fat percentage (among males), no significant relationship was observed with somatotype across gender. These findings suggest that nutrition knowledge may not strongly influence inherent body type but underscore the importance of targeted nutrition education programs to improve dietary practices and athletic performance. Further research involving larger karate athlete populations is recommended to validate and expand upon these findings.

INTRODUCTION

Karate is one of the most popular martial arts or combat sports that have been practiced all around the world (Koropanovski et al., 2011). Karate sports competition can be further divided into two distinguished disciplines, which are kata and kumite. Kata is a set of predetermined movements involving offensive and defensive action in standard order, against a non-existent opponent; meanwhile, kumite represents combat activities of karate between two karatekas under certain rules and a scoring system (Slankamenac et al., 2021).

Karate is one of Malaysia's most prominent combat sports, alongside silat, taekwondo, and boxing. Governed by the Malaysia Karate Federation (MAKAF), the sport has produced several international medalists at the 19th Asian Games in Hangzhou (2022). This achievement reflects Malaysia's growing presence in the regional karate scene and underscores the importance of understanding factors influencing athlete performance, including anthropometric profiles and sports nutrition knowledge (Malaysia Olympic Council, 2023)

Athletes need to possess specific physical attributes to perform optimally in their respective sports, including karate, which involves direct physical contact between opponents. To adapt to the demands of specific disciplines, athletes are required to exhibit somatic characteristics that align with the level and intensity of their sport (Lijewski et al., 2021). Previous studies have shown that most karate athletes, regardless of gender, exhibit an endomorphic–mesomorphic somatotype, characterized by higher muscularity and lower body fat (Slankamenac et al., 2021). In addition, anthropometric profiles play a crucial role in determining training methods and intensities that support

the physical fitness and strength requirements unique to each sport (Lijewski et al., 2021). Competing at an elite level requires athletes to maintain optimal body composition and physiological characteristics throughout the competitive season (Samanes et al., 2022). Given the strength and physical demands inherent in karate, athletes must develop and sustain specific anthropometric and somatotype profiles to enhance performance. However, most existing research emphasizing these parameters focuses on team sports, leaving a notable gap in understanding the anthropometric and somatotype requirements of combat sport athletes such as karate.

Recent studies have highlighted the importance of sports nutrition knowledge among athletes (Alahmadi & Albassam, 2023; Thapa et al., 2023). Adequate knowledge in sports nutrition is essential as it influences dietary intake and eating habits, thereby enhancing athletic performance (Alahmadi & Albassam, 2023). Combat sports, including karate, employ a weight division system to ensure fair competition between opponents. However, athletes often resort to acute weight loss (AWL) strategies, such as rapid dehydration, to qualify for lower weight categories (Reale, 2018). Therefore, it is crucial for karate athletes to possess adequate knowledge of macronutrient intake to maintain a balanced diet, achieve optimal body composition, and sustain peak performance (Reale, 2018). Furthermore, inadequate nutrition knowledge may lead to inappropriate use of supplements and dietary practices that do not align with athletes' performance goals (Alahmadi & Albassam, 2023). Nevertheless, research on sports nutrition knowledge among Malaysian karate athletes remains scarce.

Assessing athletes' anthropometric profiles is essential to determine the body morphology most suited to their sport. Previous studies have shown that appropriate anthropometric and somatotype characteristics enhance performance, reduce injury risk, and improve technical skills (Bekele et al., 2022; Čaušević et al., 2023; Kastrati et al., 2022; Slankamenac et al., 2021). However, limited research has explored the relationship between anthropometric profiles and sports nutrition knowledge, particularly among Malaysian athletes. Addressing this gap, the present study aims to identify the anthropometric profile, sports nutrition knowledge, and their association among karate athletes in Kuantan, Pahang, to better understand how nutrition knowledge may influence body composition.

MATERIALS AND METHODS

Research Design

A cross-sectional study was conducted to examine the association between anthropometric profiles and sports nutrition knowledge among karate athletes in Kuantan, Pahang. This design was selected to describe the characteristics of the athletes and explore potential relationships between variables. Data was collected through face-to-face sessions. Ethical approval was obtained from the International Islamic University Malaysia Research Ethics Committee (IIUM/504/14/11/2/IREC 2024-KAHS/DNS).

Participants

The participants of this study were selected among karate athletes who are training under the supervision of Majlis Sukan Pahang (MSP) and will be representing Pahang in the competitions. MSP is one of the government agencies that oversees the whole facilities and athletes that are chosen to train and compete for Pahang, including Karate. Athletes were included if they matched the criteria consisted of being around age 14-21 years old, registered under MSP, and competing at any level of the competition. Age 14-21 years old was considered to match the participation age for the Sukan Malaysia (SUKMA) competition. Athletes who were injured were excluded from this study.

The sample size of this study was determined using Krejcie and Morgan's sample size table (Krejcie, Morgan, 1970) as cited in Bukhari (2021). The population size of the karate were 35 and the expected sample size were 34 with 10% dropout rates were put into consideration. Purposive sampling was used in this study. The method was chosen to achieve the objective, which was very specific to only one group of the population. This purposive sampling technique followed strict inclusion and exclusion criteria for the sample. All coaches, parents, and guardians, including all other responsible parties such as the board of directors, were notified before the research was conducted.

Instruments

The assessment of this study was divided into three main parts, consisting of sociodemographic information, anthropometric profile, and sports nutrition knowledge. The sociodemographic questionnaire was adopted from the first part of the original NUKYA questionnaire by Espino et al., (2020) as cited in Nor Azizam et al., (2022). The question comprises age, gender, ethnicity, education level, entry to the state team, highest competition level, and

type of sport. Anthropometric profile of this study includes BMI, body fat percentage, and body somatotype. Meanwhile, knowledge of the athletes was assessed using the Nutritional Knowledge for Young Athletes (NUKYA) questionnaire.

Anthropometric Profile

i. BMI measurement

BMI measurement was calculated by taking the measurement of the athletes' height and body mass. Height was measured using the SECA 213 stadiometer; meanwhile, body mass was determined using the OMRON HBF-375 body fat analyzer (BIA). Both measurements were included in a formula, which is weight in kilograms (kg) divided by height in m^2 to obtain the BMI (Martinez-De-Quel et al., 2021; Villaseca-Vicuña et al., 2021).

ii. Body fat percentage

To calculate body fat percentage, body fat measurement was involved. Two sites' skinfolds were measured using a Harpenden skinfold calliper to calculate the body fat percentage, which includes triceps and subscapular. Both measurements were incorporated into the Slaughter et al., formula (Slaughter et al., 1988 as cited in Martinez-De-Quel et al., 2021):

$$BF\% = 1.33 \text{ X } \textstyle\sum 2 - 0.013 \text{ X } \textstyle\sum 2^2 - 2.5$$

where $\textstyle\sum 2$ is the summation of two skinfolds (triceps and subscapular).

iii. Body somatotype

The somatotype or body type of an individual can be categorized into three main types, which are endomorph, mesomorph, and ectomorph. To determine the somatotype, 11 required measurements were taken as follows: body mass and body height, breadth of humerus and femur bioepicondylar, 4 skinfold measurements (triceps, subscapular, supraspinale, and calf), and 2 girths, which were arm (relaxed and extended) and calf. Skinfolds were taken at the right side of the participants using the Harpenden skinfold calliper. Meanwhile, circumference measurements were taken using Lufkin tape. Additionally, the diameter of the humerus and femur was determined using a vernier calliper. All the measurement procedures were referred to the International Society for the Advancement of Kinanthropometrics (ISAK).

Next, somatotype was determined using the Carter and Heath method (Carter, 2002) as summarized in the Table 1. For endomorph, the height-corrected endomorph formula was used, where X is the summation of triceps, subscapular, and supraspinale skinfolds multiplied by

170.8 divided by height in cm(Carter, 2002). For mesomorph, Corrected Calf Girth (CCG) was used and subtracted from the skinfold in centimetres, and multiplied by pi from the calf girth. Lastly, for ectomorph decimal anthropometry depends on the Height-Weight Ratio (HWR) divided by the cube root of weight (stature/mass$^{1/3}$) (Carter, 2002).

Table 1 Decimal anthropometry formula

Somatotype	Formulae	Explanation
Mesomorph	0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height (0.131) + 4.5	Corrected Calf Girth (CCG) is obtained by subtracting the skinfold in centimetres and multiplying by pi from the calf girth. (Steward et al., 2002)
Endomorph	$-0.7182 + 0.1451(X) - 0.00068(X^2) + 0.000014(X^3)$	X – sum of triceps, subscapular, and supraspinale skinfold multiplied by (170.18/height in cm). This is a height-corrected endomorph.
Ectomorph	When HWR ≥ 40.75 Then; =0.732 HWR – 28.58 When 38.25<HWR<40.75 Then; 0.463 HWR – 17.63 When HWR ≤ 38.25 Then; =0.1	The formulae vary depending on the Height-Weight Ratio (HWR). HWR is height divided by the cube root of weight (stature/mass$^{1/3}$)

Next, the three-number somatotype rating was plotted on a 2-dimensional somatochart (*Figure 1*) by using X and Y coordinates using following formula(Carter, 2002; Slankamenac et al., 2021):

X = ectomorph – endomorph
Y = 2 X mesomorph – (endomorph + ectomorph)

Plotting the somatotype chart is important to determine the body somatotype of the athletes. It was used to identify the dominant body type of the athletes. Athletes can be classified into 13 categories. However, it can be further simplified into four larger groups:

1. Central: no component differs from another
2. Endomorph: dominant endomorphism, mesomorph, and ectomorph more than ½ unit lower
3. Mesomorph: dominant mesomorphism, endomorph, and ectomorph more than ½ unit lower
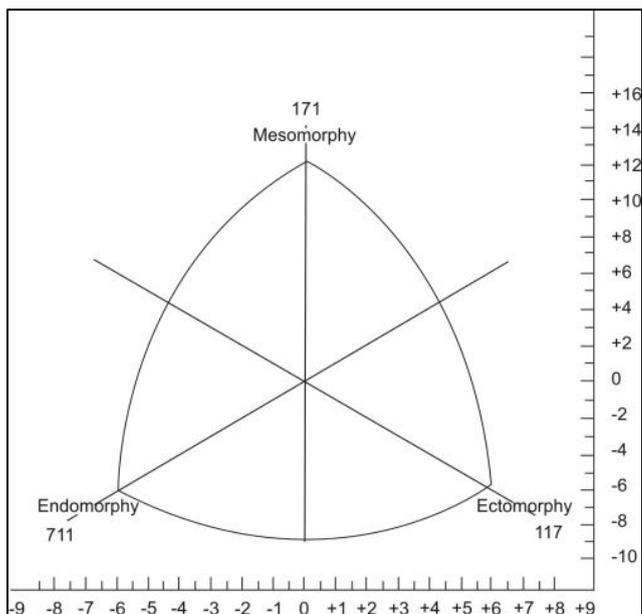4. Ectomorph: dominant ectmorphism, endomorph, and mesomorph more than ½ unit lower (Carter, 2002)

Figure 1 Example of Somatochart

Sports Nutrition Knowledge Questionnaire

The sports nutrition knowledge questionnaire was adopted from Azhar, (2023) to identify the level of sports nutrition knowledge of the athletes. The questionnaire includes 24 sets of questions with 57 items that cover 4 main sectors, which are macronutrients (27 items), micronutrients (19 items), hydration (8 items), and food periodicity (3 items). The maximum score was 57, and the minimum was 0. Participants who scored below 60% were classified as having inadequate sports nutrition knowledge, while those who scored 60% or higher were considered to have adequate knowledge (Nor Azizam et al., 2022).

Data Collection Procedure

Data collection was conducted in seven sessions. Athletes were grouped by gender, age, and competition level with assistance from the coaches. In each session, athletes alternated between completing the questionnaire and undergoing anthropometric measurements

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were applied to summarize sociodemographic data, with means and standard deviations reported for continuous variables, and frequencies and percentages for categorical variables. Associations between categorical variables were assessed using the Chi-square test, while Fisher's exact test was applied when expected cell counts were less than five. Spearman's rank-order correlation was used to examine relationships between continuous variables. All statistical tests were two-tailed, and a p-value of < 0.05 was considered statistically significant.

RESULTS

Table 2 presents the social demographic data of the 26 participants where the majority of them are males (84.6%), Malay (92.3%), with a mean age of 16.6 (±2.39) years old. Next, in terms of education level, most of the athletes were secondary school students (73.1%), and the remaining were in tertiary education.

Table 2 Sociodemographic information of the karate athletes (n=26)

Characteristics	n	%
Gender		
Male	22	84.6
Female	4	15.4
Race		
Malay	24	92.3
Indian	2	7.7
Education Level		
Secondary	19	73.1
Tertiary	7	26.9
Training level		
Preparation	10	38.5
Competition	16	61.5
Competition level		
State	3	11.5
National	8	30.8
International	15	57.7

Ten athletes were in the preparation phase of the training (38.5%), while another 16 athletes (61.5%) were in the competition phase of the training. In addition, more than half of the athletes had competed at an international level as their highest competing level (57.7%). The final response rate was 72%, as several athletes were unable to participate due to scheduling constraints, competition commitments, and limited athlete availability during the data collection period.

Table 3 shows the anthropometric profile of the karate athletes according to their gender. For male athletes, the average of body mass index (BMI) was 21.3 (±2.95) kg/m^2, while the average value for body fat percentage was 12.0 (±4.86)%. Next, based on the calculation of body somatotype, male karate athletes tended to be predominantly mesomorphic (4.8 ±1.16), with moderate levels of endomorphy (1.6 ±0.91) and ectomorphy (2.7 ±1.22). The female karate athletes had a BMI of 21.6 (±0.34) kg/m^2 and a mean body fat percentage of 24.2 (±3.43) %. Somatotype analysis using the decimal anthropometry method showed mean scores of 4.1 ± 0.84 for endomorphy, 3.2 ± 1.31 for mesomorphy, and 3.0 ± 1.68 for ectomorphy, indicating a relatively balanced somatotype with a slight predominance of endomorphic characteristics.

Next, Figure 2 illustrates the somatochart distribution of 22 male athletes. The majority (n = 14) were positioned in the ectomorphic-mesomorph region (upper right quadrant). Two athletes were located in the endomorphic-mesomorph region (upper left quadrant), while one athlete was placed on the left side of this region, and two just above it. Additionally, three athletes were distributed within the mesomorphic-ectomorph region. **Error! Reference source not found.** illustrates the somatochart distribution of four female athletes. Of these, one athlete was positioned in the endomorphic-ectomorph region (lower right quadrant), one within the mesomorphic-endomorph region (middle left quadrant), one within the ectomorphic-endomorph region, and another within the endomorphic-mesomorph region.

Figure 2 Male somatochart of karate athletes (n=22)

Table 3 Anthropometric profile of the karate athletes (n=26)

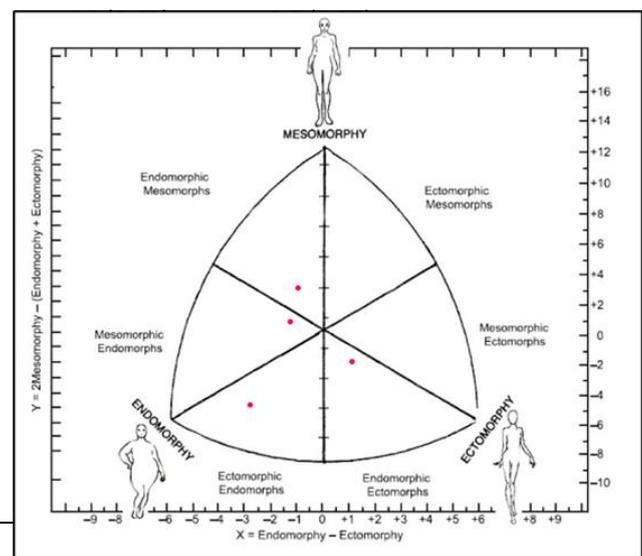| Variable	Mean (SD)		
Height (cm)	163.2 (6.38)		
Weight (kg)	57.1 (9.28)		
BMI (kg/m^2)	21.3 (2.71)	21.3 (2.95)	21.6 (0.34)
Body Fat Percentage	13.9 (6.4)	12.0 (4.86)	24.2 (3.43)
Skinfolds (mm)			
Triceps	7.2 (4.39)	5.7 (2.80)	15.2 (2.14)
Subscapular	7.9 (3.61)	7.1 (3.02)	12.6 (3.23)
Supraspinale	5.3 (3.35)		
Calf	6.4 (7.20)		
Breadths (cm)			
Hemerus	6.2 (0.39)		
Femur	9.2 (0.50)		
Girths (cm)			
Calf	34.5 (5.02)		
Arm (Relaxed)	26.8 (3.15)		
Arm (Tensed)	28.4 (2.85)		
Somatotype			
Endomorphy	2.0 (1.26)		
Mesomorphy	4.6 (1.31)		
Ectomorphy	2.7 (1.27)		
Somatochart coordinates			
X	0.7 (1.93)		
Y	4.4 (3.90)		

Figure 3 Female somatochart (n=4)

Table 4 presents the sports nutrition knowledge levels of the karate athletes. Overall, only 3 out of 26 athletes (11.5%) achieved a knowledge score above 60%, with a mean total score of 48.3 ± 10.01%. When stratified by gender, male athletes (n = 22) recorded a mean score of 46.5 ± 8.71%, while female athletes (n = 4) scored higher at 58.8 ± 11.59%. Knowledge was further assessed across seven subsections. The lowest mean score was observed in the fat knowledge category (43.2 ± 17.01%), whereas the highest was in food intake periodicity (65.4 ± 25.79%), where 18 athletes (69.2%) achieved scores above 60%.

Table 4 Sports Nutrition Knowledge (n=26)

Athletes	Total score %	Adequate Knowledge Status (>60%)	
	Mean (SD)	n	%
All (n=26)	48.3 (10.01)	3	11.5
Male (n=22)	46.5 (8.71)	1	4.5
Female (n=4)	58.8 (11.59)	2	50.0

The Fisher's exact test revealed no significant association between somatotype categories and sports nutrition knowledge adequacy among both male and female athletes (p = 1.000). Similarly, no significant correlation was observed between BMI and sports nutrition knowledge total score among male athletes (r = 0.002, p = 0.815) and between body fat percentage and sports nutrition knowledge total score among female athletes (r = –0.891, p = 0.200).

In contrast, a very strong negative correlation was found between BMI and sports nutrition knowledge total score among female athletes (r = –0.845, p = 0.0001) (Figure 4), indicating that athletes with higher BMI tended to have lower sports nutrition knowledge. Additionally, a moderate positive correlation was observed between body fat percentage and sports nutrition knowledge total score among male athletes (r = 0.427, p = 0.007) (Figure 5), suggesting that higher body fat percentage was associated with higher sports nutrition knowledge.
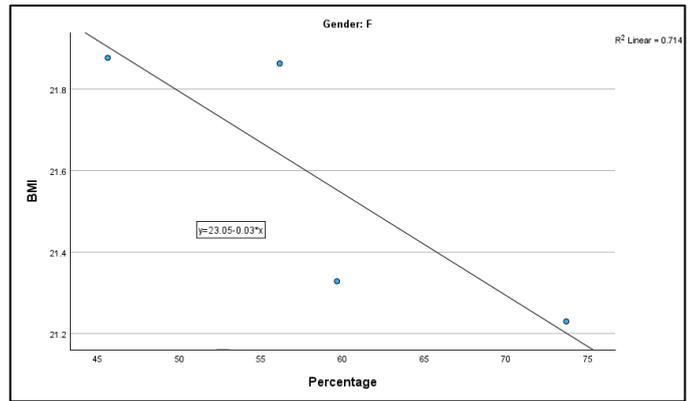

Figure 3 Association between Body Mass Index (BMI) and sports nutrition knowledge of female athletes.
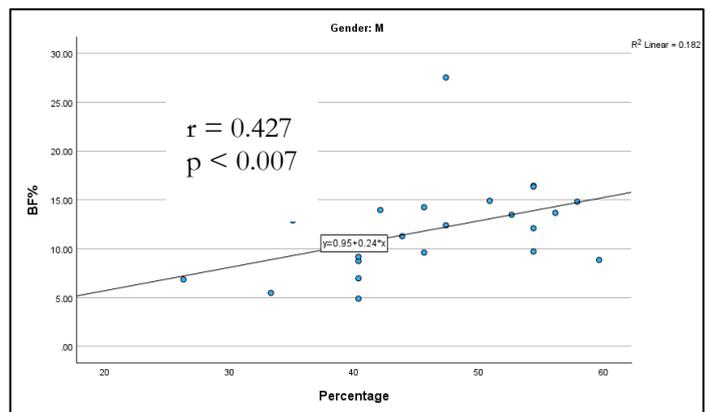

Figure 4 Association between body fat percentage and sports nutrition knowledge of male karate athletes.

DISCUSSION

This study identified the association between anthropometric profiles (body somatotype, body mass index [BMI], and body fat percentage) and sports nutrition knowledge (SNK) among karate athletes in Kuantan, Pahang. The findings demonstrated no significant association between body somatotype and SNK for both male and female athletes. With regard to BMI, no association was observed among male athletes, whereas a negative association was found among female athletes. For body fat percentage, a positive association with SNK was identified in male athletes, while no significant association was seen in female athletes. These results indicate that the relationship between anthropometry and SNK may differ by sex and by specific anthropometric indicators.

Anthropometric Profile

The anthropometric profile of the karate athletes in this study was evaluated through somatotype, BMI, and body fat percentage. Male athletes predominantly displayed an ectomorphic-mesomorphic somatotype, with only a few located in the endomorphic-mesomorphic region. This finding contrasts with a study by Slankamenac et al., (2021), which reported a predominant endomorphic-mesomorph somatotype among male karate athletes. Alkhayl et al. (2022) suggest that Asian populations may exhibit different upper-body strength and fat metabolism characteristics compared to Europeans, which may explain the contrast in the findings. Overall, the male karate athletes in this study exhibited a higher mesomorphic physique, indicating significant musculoskeletal robustness. This physique provides a muscle mass and strength advantage, beneficial for performance in combat sports (Tetiana et al., 2017).

Nevertheless, female athletes in this study exhibited greater variability, with four different somatotype classifications identified. Similar variations were reported by Bahamondes-Avil et al., (2023), who observed central, endomorphic-mesomorphic, and mesomorphic-endomorphic characteristics among their female karate athletes. Furthermore, Chaabene et al (2012) highlighted that elite-level female karatekas often exhibit mesomorphic-ectomorphic characteristics, emphasizing the importance of lower body fat and leaner profiles for optimal performance.

Regarding BMI, results revealed an average value of 21.3 (±2.95) kg/m² in male athletes and 21.6 (±0.34) kg/m² in female athletes. Compared to their non-athlete peers (Rezali et al., 2012), both groups demonstrated higher BMI, likely reflecting increased muscle mass. However, when comparing with other karate athletes, the male BMI values were lower than those reported by Martinez-De-Quel et al., (2021), which could be explained by differences in somatotype distribution. Female athletes, on the other hand, demonstrated BMI values consistent with previous studies, suggesting comparable trends across populations Martinez-De-Quel et al., 2021). While BMI is widely used, it does not differentiate between fat and lean mass, thus limiting its accuracy in reflecting body composition

In this study, male athletes exhibited a mean body fat percentage (BF%) of 12.0% (± 4.86). This is lower than the mean values previously reported for both Malaysian adolescent karateka (17.0% ± 12.8) (Aziz et al., 2025) and young male Spanish karatekas (21.3% ± 4.5) (Martinez-De-

Quel et al., 2021). This comparative leanness accords with the predominantly ectomorphic–mesomorphic somatotype observed within the male sample of this study, which prioritizes musculoskeletal development over adiposity. In contrast, female athletes in the present study recorded a mean BF% of 24.2% (± 3.43). This value is substantially lower than the median BF% (~34.3%) observed in the Malaysian cohort reported by Aziz et al. (2025), and it is also lower than the mean BF% (27%) reported for young female Spanish karatekas (Martinez-De-Quel et al., 2021).

Taken together, the anthropometric findings suggest that both male and female karate athletes in this study generally demonstrated suitable body composition for competitive performance, though variations existed across somatotype, BMI, and body fat percentage. However, optimal anthropometric characteristics alone may not be sufficient to sustain performance without adequate sports nutrition knowledge, which plays a critical role in supporting training, recovery, and long-term health.

Sports Nutrition Knowledge

In this study, most karate athletes demonstrated inadequate levels of sports nutrition knowledge. This finding is consistent with reports among professional karate athletes in Ankara, Turkey, who also exhibited weak nutrition knowledge (mean score 34.18 ± 13.84) (Gobel, 2023). Such limited understanding is concerning, as established literature indicates that insufficient nutrition knowledge can negatively affect dietary quality, hinder recovery processes, and ultimately compromise overall athletic performance (Chaabène et al., 2012; Tabben et al., 2023). These results reinforce concerns that athletes may not be adequately equipped to translate nutritional requirements into practice, despite the high physical and metabolic demands of combat sports. Collectively, these findings highlight the urgent need for structured nutrition education and counselling programs tailored for karate athletes to enhance knowledge, improve dietary behaviors, and optimize performance outcomes.

Association of Anthropometric Profile and Sports Nutrition Knowledge of Karate Athletes.

The relationship between sports nutrition knowledge (SNK) and anthropometric indicators such as body fat percentage and somatotype is multifactorial and not always linear. In this study, a positive correlation between SNK and body fat percentage was observed among male athletes, indicating that greater nutrition knowledge did not necessarily

correspond to lower fat levels. This suggests a knowledge–practice gap, where athletes may possess adequate theoretical understanding but face challenges in consistently applying this knowledge to maintain optimal body composition.

The correlation between sports nutrition knowledge and body fat percentage is a complex subject that has been explored through various studies. Generally, higher sports nutrition knowledge correlates with better dietary habits and lower body fat percentage among athletes, although certain factors could potentially lead to higher body fat levels despite increased knowledge.

Research indicates that athletes with a strong understanding of sports nutrition often exhibit healthier dietary habits, positively influencing their body composition. For instance, Jagim et al., (2021) found that collegiate athletes with higher sports nutrition knowledge tended to have lower body fat percentages and fat mass, highlighting an inverse relationship between nutrition knowledge and body fat levels. This finding is echoed by Magee et al., (2023), who reported that athletes with greater nutrition knowledge were more likely to consume higher amounts of essential nutrients, such as carbohydrates and proteins, while minimizing unhealthy fats. This behavioral pattern supports maintaining a lower body fat percentage.

However, the relationship can be more intricate, especially when considering the possibility of higher body fat percentages despite strong nutrition knowledge. One contributing factor could be how athletes apply their nutritional knowledge in practice. Bakhtiar et al., (2021) noted that while older athletes often have more extensive nutrition training, their higher body mass index (BMI) is not directly correlated with their nutrition knowledge level, suggesting that age and other factors may influence body composition more than knowledge alone. Athletes may experience challenges in translating their knowledge into effective dietary practices, which can lead to continued accumulation of body fat.

Moreover, Staśkiewicz et al., (2023) emphasized that even with improved nutrition knowledge, complex determinants like lifestyle choices, metabolism variations, and psychological factors can hinder the achievement of optimal body fat levels. Even with an enhanced awareness of nutritional needs, athletes might still consume excess calories or fail to align their macronutrient distributions with performance demands, potentially resulting in higher fat mass.

Additionally, certain interventions aimed at improving nutrition knowledge do not always result in significant changes in dietary behaviors. For instance, Alvita Ghany et al., (2023) demonstrated that while nutrition education can enhance knowledge, it may not necessarily correlate with immediate behavioral changes regarding food choices. This disconnect can inadvertently lead to weight gain or the maintenance of higher body fat percentages among some athletes despite their understanding (Ghany et al., 2023). Such gaps highlight the complexity of the relationship between knowledge and practical application in nutritional habits.

Consequently, even as nutrition knowledge increases among athletes, it is essential to emphasize not only a theoretical understanding of dietary principles but also the comprehension of individual body needs, applying knowledge effectively, and integrating suitable lifestyle practices. This suggests that a high level of knowledge alone does not guarantee optimal body fat outcomes as knowledge does not consistently translate into healthier dietary behaviours due to various psychological, environmental, and lifestyle influences (Spronk et al., 2014; Contento, 2008; Heaney et al., 2011).

Consistent with this multifactorial relationship, the present study also found a significant negative correlation between sports nutrition knowledge and BMI among female athletes. This aligns with earlier findings showing that female athletes often demonstrate higher adherence to nutrition recommendations and place greater emphasis on weight management strategies compared to their male counterparts (Heaney et al., 2011; Hull et al., 2016). Research also suggests that female athletes tend to engage more actively in behaviour change when equipped with nutrition knowledge, resulting in more effective weight-control practices and healthier anthropometric profiles (Spronk et al., 2014). These gender-specific patterns indicate that the relationship between nutrition knowledge and anthropometric outcomes may differ by sex, underscoring the need for tailored nutrition education strategies

In contrast, no significant association was found between sports nutrition knowledge (SNK) and somatotype, suggesting that body type is influenced by factors beyond nutrition knowledge and less straightforward. Somatotype, which categorizes individuals based on body composition, often does not align as clearly with the level of nutritional understanding among athletes. One possible explanation for this disparity is that while nutrition knowledge can influence body composition, somatotype is also affected by genetic factors, training regimens, and overall body

structure that are independent of dietary practices (Penggalih et al., 2021). Research indicates that different sports typically attract individuals of varying somatotypes that fit the demands of the sport (e.g., endurance vs. strength sports) (González Macías & Flores, 2024). This specificity means that not all athletes with substantial nutritional knowledge will exhibit a somatotype corresponding to nutritional ideals recognized in sports.

Furthermore, while nutrition knowledge might positively influence dietary practices, several studies suggest that the actual impact on somatotype is influenced by broader factors, including lifestyle, genetics, and training methodologies, which may not be easily modified through education alone (Heaney et al., 2008; Janiczak et al., 2021). Indeed, barriers to optimal nutrition practices can exist despite elevated knowledge levels, as factors such as motivation, situational factors, and peer influence also significantly impact dietary choices among athletes (Ahmadi et al., 2022).

Strength and Limitation

This study is among the first to assess the association between anthropometric profiles and sports nutrition knowledge among Malaysian karate athletes, providing valuable baseline data for future research. The use of a validated and culturally adapted Nutrition Knowledge for Young Athletes questionnaire (Nor Azizam et al., 2022) and standardized ISAK anthropometric procedures strengthened the reliability and validity of the findings.

However, the small sample size particularly the limited number of female participants and the recruitment of athletes from only one region in Malaysia (Pahang) restricts the generalizability of the results. In addition, time constraints and the unavailability of advanced body composition tools may also have limited the depth of data collected. Despite these challenges, the study was conducted rigorously, and the findings remain meaningful within the context of Malaysian karate athletes.

CONCLUSION

This study revealed that while the karate athletes generally exhibit suitable physical characteristics for combat sports, their overall SNK levels are inadequate. Furthermore, a positive correlation between nutrition knowledge and body fat percentage was identified among male athletes only, whereas no significant association was observed between knowledge and somatotype in either gender. These findings suggest that greater nutrition knowledge does not necessarily translate into optimal body composition, highlighting a knowledge practice gap among athletes. Therefore, future interventions should focus not only on improving knowledge but also on promoting behavioral change and the practical application of nutrition principles. Expanding this research with larger and more diverse athlete samples may further clarify the influence of nutrition education on anthropometric and performance outcomes.

REFERENCES

Abdul, S., Bukhari, R., & Ali, M. (2021). Sample Size Determination Using Krejcie and Morgan Table. https://doi.org/10.13140/RG.2.2.11445.19687

Ahmadi, F., Ebrahimi, M., & Kashani, V. (2022). Sports Nutritional Knowledge, Attitude, and Practice of Adolescent Athletes in Tehran, Iran. Asian Journal of Sports Medicine. https://doi.org/10.5812/asjsm-131584

Alkhayl, F. F. A., Ismail, A. D., Celis-Morales, C., Wilson, J., Radjenovic, A., Johnston, L., Welsh, P., Sattar, N., Gill, J. M. R., Preston, T., & Gray, S. R. (2022). Muscle protein synthesis and muscle/metabolic responses to resistance exercise training in South Asian and White European men. Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-06446-7

Alvita Ghany, R. M., Hastuti, J., & Muslichah, R. (2023). Nutritional Status and Performance of Sepak Takraw Players Following Intervention by a Sports Dietitian. Journal of Health and Translational Medicine. https://doi.org/10.22452/jummec.vol26no2.18

Azhar, M. I. H. (2023). Sports nutrition knowledge and practice among adolescent athletes in Kuantan, Pahang (Unpublished master's thesis). International Islamic University Malaysia.

Aziz, M. A., Kunnabal, P., & Mohamed, N. A. (2025). Anthropometric and Physical Fitness Component Profiles in Malaysian Adolescence Recreational Karateka. Journal of Health Science and Medical

Research, 43(3), 1–10. https://doi.org/10.31584/jhsmr.20251142

Bakhtiar, M., Masud-ur-Rahman, Md., Kamruzzaman, Md., Sultana, N., & Rahman, S. S. (2021). Determinants of Nutrition Knowledge, Attitude and Practices of Adolescent Sports Trainee: A Cross-Sectional Study in Bangladesh. Heliyon. https://doi.org/10.1016/j.heliyon.2021.e06637

Bekele, B. A., Adane, A. K., & Kabiso, T. A. (2022). Anthropometric Characteristics Of Volleyball Players With Respect To Playing Positions: In Ethiopian Female Premier League. Central European Journal of Sport Sciences and Medicine, 39(3), 65–73. https://doi.org/10.18276/cej.2022.3-05

Carter, J. E. L. (2002). The Heath-Carter Anthropometric Somatotype-Instruction Manual-Somatotype Instruction Manual 2 Part 1: The Heath-Carter Anthropometric Somatotype-Instruction Manual. www.tep2000.com

Čaušević, D., Rani, B., Gasibat, Q., Čović, N., Alexe, C. I., Pavel, S. I., Burchel, L. O., & Alexe, D. I. (2023). Maturity-Related Variations in Morphology, Body Composition, and Somatotype Features among Young Male Football Players. Children, 10(4). https://doi.org/10.3390/children10040721

Contento I. R. (2008). Nutrition education: linking research, theory, and practice. Asia Pacific journal of clinical nutrition, 17 Suppl 1, 176–179.

Göbel, P. (2023). Nutrition knowledge levels and nutritional supplement beliefs of professional karate athletes. Journal of Health Sciences and Medicine, 6(1), 51-58. https://doi.org/10.32322/jhsm.1198884

González Macías, M. E., & Flores, J. (2024). Somatotype, Anthropometric Characteristics, Body Composition, and Global Flexibility Range in Artistic Gymnasts and Sport Hoop Athletes. Plos One. https://doi.org/10.1371/journal.pone.0312555

Heaney, S., O'Connor, H., Naughton, G., & Gifford, J. (2008). Towards an Understanding of the Barriers to Good Nutrition for Elite Athletes. International Journal of Sports Science & Coaching, 3(3), 391–401. https://doi.org/10.1260/174795408786238542

Heaney, S., O'Connor, H., Michael, S., Gifford, J., & Naughton, G. (2011). Nutrition knowledge in athletes: a systematic review. International journal of sport nutrition and exercise metabolism, 21(3), 248–261. https://doi.org/10.1123/ijsnem.21.3.248

Hull, M. V., Jagim, A. R., Oliver, J. M., Greenwood, M., Busteed, D. R., & Jones, M. T. (2016). Gender differences and access to a sports dietitian influence dietary habits of collegiate athletes. Journal of the International Society of Sports Nutrition, 13, 38. https://doi.org/10.1186/s12970-016-0149-4

Jagim, A. R., Fields, J. B., Magee, M. K., Kerksick, C. M., Luedke, J., Erickson, J. L., & Jones, M. T. (2021). The Influence of Sport Nutrition Knowledge on Body Composition and Perceptions of Dietary Requirements in Collegiate Athletes. Nutrients. https://doi.org/10.3390/nu13072239

Janiczak, A., Devlin, B. L., Forsyth, A., & Trakman, G. L. (2021). A Systematic Review Update of Athletes' Nutrition Knowledge and Association With Dietary Intake. British Journal of Nutrition. https://doi.org/10.1017/s0007114521004311

Kastrati, A., Gashi, N., Georgiev, G., Gontarev, S., & Kastrati, A. (2022). Somatotype Characteristics of Elite Young Athletes from the Republic of Kosovo. Sport Mont, 20(3), 47–52. https://doi.org/10.26773/smj.221008

Koropanovski, N., Berjan, B., Bozic, P. R., Pazin, N., Sanader, A., Jovanovic, S., & Jaric, S. (2011). Anthropometric and physical performance profiles of elite karate kumite and kata competitors. Journal of Human Kinetics, 30(1), 107–114. https://doi.org/10.2478/v10078-011-0078-x

Lijewski, M., Burdukiewicz, A., Stachoń, A., & Pietraszewska, J. (2021). Differences in anthropometric variables and muscle strength in relation to competitive level in male handball players. PLoS ONE, 16(12 December). https://doi.org/10.1371/journal.pone.0261141

Magee, M. K., Jones, M. T., Fields, J. B., Kresta, J., Khurelbaatar, C., Dodge, C., Merfeld, B., Ambrosius, A., Carpenter, M., & Jagim, A. R. (2023). Body Composition, Energy Availability, Risk of Eating Disorder, and Sport Nutrition Knowledge in Young Athletes. Nutrients. https://doi.org/10.3390/nu15061502

Martinez-De-Quel, O., Alegre, L. M., Castillo-García, A., & Ayán, C. (2021). Anthropometric and fitness normative values for young karatekas. Biology of Sport, 38(3),

351–357. https://doi.org/10.5114/BIOLSPORT.2021.99324

Nor Azizam, N. S., Yusof, S. N., Amon, J. J., Ahmad, A., Safii, N. S., & Jamil, N. A. (2022). Sports Nutrition and Food Knowledge among Malaysian University Athletes. Nutrients, 14(3). https://doi.org/10.3390/nu14030572

Penggalih, M. H. S. T., Solichah, K. M., Dewinta, M. C. N., Niamilah, I., Nadia, A., Pratiwi, D. E., … & Bactiar, N. (2021). Comparison of somatotype profiles and dietary intake of football athletes in different playing levels in indonesia. Jurnal Gizi Klinik Indonesia, 18(1), 18. https://doi.org/10.22146/ijcn.64653

Reid Reale. (2018). Acute Weight Management In Combat Sports: Pre Weigh-In Weight Loss, Post Weigh-In Recovery And Competition Nutrition Strategies. Gatorade Sports Science Institute , 31, 1–6.

Rezali, F. W., Chin, Y. S., & Yusof, B. N. M. (2012). Obesity-related behaviors of Malaysian adolescents: A sample from Kajang district of Selangor state. Nutrition Research and Practice, 6(5), 458–465. https://doi.org/10.4162/nrp.2012.6.5.458

Slankamenac, J., Bjelica, D., Jaksic, D., Trivic, T., Drapsin, M., Vujkov, S., Modric, T., Milosevic, Z., Drid, P., Campa, F., & Greco, G. (2021). Somatotype Profiles of Montenegrin Karatekas: An Observational Study. Public Health, 18, 12914. https://doi.org/10.3390/ijerph

Staśkiewicz, W., Grochowska-Niedworok, E., Zydek, G., Białek-Dratwa, A., Grajek, M., Jaruga-Sękowska, S., Kowalski, O., & Kardas, M. (2022). Changes in Body Composition During the Macrocycle of Professional Football Players in Relation to Sports Nutrition Knowledge. Frontiers in Nutrition. https://doi.org/10.3389/fnut.2022.981894

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. The British journal of nutrition, 111(10), 1713–1726. https://doi.org/10.1017/S0007114514000087

Staśkiewicz, W., Grochowska-Niedworok, E., Zydek, G., Grajek, M., Krupa-Kotara, K., Białek-Dratwa, A., Jaruga-Sękowska, S., Kowalski, O., & Kardas, M. (2023). The Assessment of Body Composition and Nutritional Awareness of Football Players According to Age. Nutrients. https://doi.org/10.3390/nu15030705

Stewart, A. D., Stewart, A., & Reid, D. M. (2002). Correcting calf girth discriminates the incidence of falling but not bone mass by broadband ultrasound attenuation in elderly female subjects. Bone, 31(1), 195–198. https://doi.org/10.1016/s8756-3282(02)00811-6.

Sunuwar, D. R., Singh, D. R., Bohara, M. P., Shrestha, V., Karki, K. B., & Singh Pradhan, P. M. (2022). Association of Nutrition Knowledge, Practice, Supplement Use, and Nutrient Intake With Strength Performance Among Taekwondo Players in Nepal. Frontiers in Nutrition. https://doi.org/10.3389/fnut.2022.1004288

Thapa, M., Neupane, A., Shrestha, S. K. D., Nepal, P., Upadhyaya, A., Niraula, P., Shrestha, R. K., & Sunuwar, D. R. (2023). Factors affecting nutritional knowledge, attitude, practices and dietary intake among national players in Kathmandu, Nepal: a cross-sectional study. BMC Sports Science, Medicine and Rehabilitation, 15(1). https://doi.org/10.1186/s13102-023-00691-7

Villaseca-Vicuña, R., Molina-Sotomayor, E., Zabaloy, S., & Gonzalez-Jurado, J. A. (2021). Anthropometric profile and physical fitness performance comparison by game position in the Chile women's senior national football team. Applied Sciences (Switzerland), 11(5), 1–16. https://doi.org/10.3390/app11052004Arksey,