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Anthropometric and Physical Fitness Component Profiles in Malaysian Adolescence Recreational Karateka

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Abstract:

Objective: Measuring the physical fitness components of athletes provides crucial information in designing an individual training program to enhance performance. However, a huge gap is identified, in the lack of baseline physical fitness profiles among Malaysian adolescence Karateka. Our objective is to describe the physiological profiles of Malaysian adolescence Karateka.

Material and Methods: This cross-sectional study was conducted in the Klang Valley; at eight Karate training facilities in participants aged 13-19 years old. Demographic data, anthropometric and short physical performance batteries, 3-minute YMCA step test, Jamar handgrip dynamometer test 3-minutes and 1-minute sit-up test were collected and analysed using statistical package for social sciences version 26.

Results: The mean age was 15.8±1.8 years. The mean body mass index was 21.5±4.5 kg.m^2, the mean VO2 peak was 59.0±12.4 ml.kg.min, and the mean hand grip strength was 30.7±9.3 kg. Karateka in higher age groups (18-19 years) had a significantly higher weight (median=64.4, p-value=0.003), higher skeletal muscle mass (median=27.6, p-value=0.006), higher hand grip strength (median=37, p-value=0.000), and higher 1 min sit up test (median=32, p-value=0.071). Male Karateka had a higher skeletal muscle mass (median=25.9 kg, p-value=0.000), higher hand grip strength (median 33.1 kg, p-value=0.000), higher 1 minute sit-up test (median=32, p-value=0.001) and higher VO2 peak (median 67.2 ml.kg.min, p-value=0.000).

Conclusion: This serves as baseline anthropometric and physical fitness profiles among Malaysian adolescence Karateka.

Keywords: adolescence, karate, muscle strength, martial arts

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Introduction

Martial arts are a type of sport that involves offensive and defensive combat sports, with or without weapons. In Malaysia, the top three combat sports commonly practiced are Karate, Taekwondo and Silat[1]. Karate originated from Japan, and it is one of the most attractive combat sports practiced worldwide. It has two main categories; (i) sparring (Kumite) and (ii) forms (Kata) and individual Kumite are subdivided into age and weight divisions. Kata involved technique, rhythm, power, expression of movement and Kime[2]. Kime is assessed based on short isometric muscle contraction when the technique is finished[2]. In contrast, Kumite is a combat between two Karateka that involves kicks and punches, both as offense and defense[2].

Physical fitness includes: cardiorespiratory fitness, muscular strength, muscular endurance and body composition, which are integral parts to maintain performance in all sports. Cardiorespiratory endurance refers to the ability of the heart and lungs to deliver oxygen to working muscles during continuous physical activity[3]. Muscular strength reflects the muscle's ability to exert a maximal force on a single occasion[3]. There are no single components that dominate in Karate, as it requires a mix of technique, strength, aerobic fitness, power and speed. According to Baker and Bell, Karate is a high-intensity type of sport[4]. Karate requires highly developed explosive power and speed, which is constantly addressed during training[5,6]. In a systematic review, martial arts programs reported a statistically significant improvement in physical fitness among pre-school and school children[7]. Kryopenko et al.[7] introduced the Kyokushinkai Karate program for 24 months in 27 school children aged 10–12 years and found a large statistical improvement (p-value<0.01) in cardiorespiratory endurance compared to the control group. Pavlova et al. reported a significant improvement in lower limb strength (p-value<0.01) in children that participated in their Karate program[8]. Another, vital component of physical fitness is core strength. Core strength is defined as the core or trunk muscles capacity to produce and maintain force[3]. Core strength is vital in Karate, as Karateka requires good stability during punching and kicking moves[9,10]. A study by Kabadayi et al. (2022) showed improved Karate kick performance when core endurance is improved[10].

The challenge faced by both coaches and athletes is to understand the effects of physical fitness components on performance. Measuring the physical fitness components of athletes provides important information in a selection of athletes and when designing an individual training program to enhance performance. However, a huge gap is identified in terms of the lack of baseline physical fitness profiles among Malaysian adolescence Karateka. A review article on the physiological profiles of Karateka has focused on a mixture of adult and young elite athletes; however, none of the athletes were Malaysian[11]. A study in Malaysia, which focused on the physiological profiles of Malaysian combat sports athletes, did not include Karateka in their study[12]. With current limitations, our objective is to describe the physiological profiles of Malaysian adolescence recreational Karateka as a baseline, to help facilitate the development of focused training programs in adolescence Karateka.

Material and Methods

Study design

This cross-sectional study was conducted in the Klang Valley, at eight Karate training facilities via convenience sampling. All Karateka, aged between 13–19 years old, regardless of gender, experience level, or belt rank were enrolled. At the training centres, each participant received personal information about the study and the consent form. Prior to the study's execution, the Karateka provided informed consent; in the case of individuals under the age of 18, consent was sought from their parent or

legal guardian. For each Karateka, these were completed at the training sites, assisted by the principal investigator. Ethical approval for the conduct of the study was obtained from the University of Malaya Research Ethics Committee (UM.TNC2/UMREC_2256.)

Data collection

Data was collected from 1st January 2023 to 31st December 2023. Karateka was required to fill in a questionnaire via Google form regarding demographics. The data included age, date of birth, gender, belt ranking, and years of experience.

Body composition

All findings were recorded in a standard clinical research form. Using portable bioelectrical impedance analysis (BIA), baseline body composition measurements were made for weight, skeletal muscle mass, body fat mass, body fat percentage and body mass index (BMI). The InBody H20N portable BIA, made in South Korea was utilized. Height was assessed via a stadiometer. They also underwent a short battery of physical tests to assess other fitness parameters, namely, the 3-minute YMCA step test, Jamar handgrip dynamometer test and 1-minute sit-up test.

YMCA step test

A two-minutes rest period preceded the test, with participants sitting in a calm room with standard air conditioning. For three minutes, Karateka had to step up and down on a 30.5-cm box (step up-up-down-down). The metronome, which was calibrated to 96 beats per minute, displayed the stepping frequency. When the test was over, the Karateka instantly stopped, sat down and remained motionless. The Karatekas' heartrates were tracked for a minute using an RS PRO pulse oxymeter. Karateka maintained a recovery period for a total of 5 minutes[3,13,14].

VO2max was calculated using an equation formulation[3]:

Male Karateka:

$$VO2max\ (mL \bullet kg^{-1} \bullet min^{-1}) = 111.33 - (0.42 \times HR)$$

Female Karateka:

$$VO2max\ (mL \bullet kg^{-1} \bullet min^{-1}) = 65.81 - (0.1847 \times HR)$$

wherein HR = heart rate (beats • min^{-1})

Hand grip strength

The Karateka were seated straight in a chair with their hips and knees at a 90-degree angle and their backs supported. The dominant hand was selected. The dominant side's shoulder was abducted against the body, the elbow was in an unsupported 90° flexion, and the wrist was in a neutral posture. The Karateka were then advised to use their dominant hand to grip the Jamar Plus+ Digital hand-held dynamometer as firmly as they could. For every test, three measurements were taken, and the highest value was utilized for analysis[3].

One minute sit-up test

The abdominal muscles' endurance and strength were assessed with a one-minute sit-up test. With their knees bent and their feet around 12 inches from their buttocks, athletes lie supine. The assessor placed the athlete's hands on the other shoulder, positioned the athlete's arms flat over their chest and placed the athlete's feet on the ground. Karateka lifted their torsos while maintaining their arm positions, curling up until their elbows contacted their thighs and then lowering themselves back down to the floor until their upper back or shoulder blades, touched it. The most sit-ups that could be completed in a minute were recorded[15].

Statistical analysis

Age, Baseline anthropometric (weight, height, BMI, skeletal muscle mass, percentage body fat (PBF)) and baseline fitness assessments (hand grip strength, 1 minute sit-up test and VO2 peak) are presented in mean and standard deviation and demographic data (gender, hand dominant, belt rank, and years of training) are presented in frequency and percentage.

We performed a comparison of anthropometric and physical fitness components among different age categories in Karate (13 years old, 14-15 years, 16-17 years, and 18-19 years), gender (male and female) and experience in Karate (1-5 years, 6-10 years, 11-15 years, >15 years). Test of normality, using Shapiro Wilks test, found that these groups were not normally distributed. Thus, the Krussal Wallis H test was used for comparison between each group and expressed as median (interquartile range) and a p-value<0.05 was considered significant. Using Pearson correlation, the correlation was examined between age, anthropometric and physical fitness components. The r^2 is expressed as a coefficient value; ±0.50 and ±1 indicates strong correlation±0.30 and ±0.49 indicate moderate correlation, and less than 0.30 indicate small correlation: a p-value<0.05 was considered significant.

Results

There 119 adolescences that participated in this study, ranging from 13 to 19 years of age. The mean age was 15.8±1.8 years. Males were predominant in this study (n=80, 67.2%). Most of Karateka in our study had experience of 6-10 years (n=62, 52.1%). The mean BMI in our study was 21.5±4.5 kg.m^2, which falls under the normal BMI category. For the fitness test, the mean VO2 peak was 59.0±12.4 ml.kg.min, and the mean dominant hand grip strength was 30.7±9.3 kg. The details of baseline anthropometric and physical fitness are outlined in Table 1.

Table 1 Baseline anthropometric assessment in 119 adolescence Karate athletes

Anthropometric assessments	Value
Age	15.6 (1.8)*
Gender	
Female	39 (32.8)**
Male	80 (67.2)**
Karate Belt	
Black	35 (29.4)**
Blue	8 (6.7)**
Brown	61 (53.1)**
Green	2 (1.7)**
Purple	9 (7.6)**
Yellow	4 (3.4)**
Experience in training (years)	
1-5	33 (27.7)**
6-10	62 (52.1)**
11-15	19 (16)**
>15	5 (4.2)**
Dominant Hand	
Right hand	1044 (87.2)**
Left hand	15 (12.6)**
Anthropometric	
Height (cm)	165.7 (9.1)*
Weight (kg)	59.4 (14.3)*
Body mass index (kg.m^2)	21.5 (4.5)*
Skeletal muscle mass (kg)	24.1 (5.5)*
Percentage body fat (%)	24.8 (11.2)*
Physical fitness test	
Dominant hand grip strength (kg)	30.7 (9.3)*
1-min sit-up test (repetition)	31.4 (8.5)*
VO2 peak (ml.kg.min)	59.0 (12.4)*

*expressed as mean (S.D.), **expressed as frequency (percentage)

When comparing between different age groups, Karateka in the higher age group (18-19 years) had a significantly higher weight (median=64.4, p-value=0.003), higher skeletal muscle mass (median=27.6, p-value=0.006), higher hand grip strength (median=37, p-value=0.000), and higher 1 min sit-up test (median=32, p-value=0.071): as outlined in Table 2. When performing a correlation between age, anthropometric and physical fitness components, an

increasing age had a moderate correlation with dominant hand grip strength (r^2=0.531, p-value=0.000) but a weak correlation on BMI (r^2=0.228, p-value=0.012), and skeletal muscle mass (r^2=0.354, p-value=0.000): as shown in Table 3.

When comparing between gender, male Karateka has a higher skeletal muscle mass (median=25.9 kg, p-value=0.000), hand grip strength (median=33.1 kg, p-value=0.000), higher 1 minute sit up test (median=32, p-value=0.001) and higher VO2 peak (median 67.2 ml.kg.min, p-value=0.000). In contrast, females had higher BMI (median=22.2 kg.m^2), and body fat percentage (median=34.3%, p-value=0.000), as shown in Table 4.

When comparing experience, there was no-significant higher VO2 peak (median=65.1 ml.kg.min, p-value=0.474), and hand grip strength (median=38 kg, p-value=0.074) in Karateka with experience>15 years (Table 5).

Table 2 Comparison of anthropometric and physical fitness components among different age groups

Age group	13 Years	14-15 Years	16-17 Years	18-19 Years	p-value
Anthropometric					
Height (cm)	163 (8.5)	165 (15)	164 (15)	172 (15.2)	0.044
Weight (kg)	52.2 (12.3)	50.9 (13.3)	57.7 (14.7)	64.4 (19.5)	0.003
Body mass index (kg.m^2)	19.6 (4.35)	19.6 (5.6)	21 (4.9)	21.1 (6.34)	0.162
Skeletal muscle mass (kg)	22 (4.9)	21.4 (7.4)	25.6 (7.9)	27.6 (8.6)	0.006
Percentage body fat (%)	24.1 (17.7)	26.9 (18.4)	24.9 (19.5)	19 (23.8)	0.976
Physical fitness component					
Dominant hand grip strength (kg)	23.3 (7.9)	26.5 (10.9)	32 (10.8)	37 (20.1)	0.000
1-minute sit-up test (repetition)	32 (8.5)	29 (11)	34 (13)	32 (12.2)	0.071
VO2 peak (ml.kg.min)	53.3 (18.5)	60.6 (23.05)	62.2 (27.2)	64.2 (20.8)	0.186

Krussal Wallis H test: results are expressed as mean (standard deviation)
p-value<0.05 is considered as significant

Table 3 Correlation between age, anthropometric and physical fitness components

Anthropometric & physical fitness component	Age
Anthropometric	r^2 (p-value)
Weight (kg)	0.305 (0.001)
Body mass index (kg.m^2)	0.228 (0.012)
Skeletal muscle mass (kg)	0.354 (0.000)
Percentage body fat (%)	0.018 (0.846)
Physical fitness component	
Dominant hand grip strength (kg)	0.531 (0.000)
1-minute sit-up test (repetition)	0.206 (0.024)
VO2 peak (ml.kg.min)	0.133 (0.150)

Pearson correlation was used r^2 is correlation coefficient; r^2±0.50 and ±1 is strong correlation, ±0.30 and ±0.49 is moderate correlation and <0.3 is small correlation, p-value<0.05 is considered as significant

Table 4 Comparison of anthropometric and physical fitness components among different genders

Gender	Female	Male	p-value
Anthropometric			
Height (cm)	158 (6)	169.5 (11)	0.000
Weight (kg)	54.8 (13)	57 (17.9)	0.203
Body mass index (kg.m^2)	22.2 (5)	19.6 (4.6)	0.014
Skeletal muscle mass (kg)	19.3 (3.9)	25.9 (6.8)	0.000
Percentage body fat (%)	34.3 (8.4)	17 (12.8)	0.000
Physical fitness component			
Dominant hand grip strength (kg)	24.6 (7.3)	32.6 (11)	0.000
1-minute sit-up test (repetition)	27 (10.5)	32 (10)	0.001
VO2 peak (ml.kg.min)	43.2 (3.1)	67.2 (11.9)	0.000

Krussal Wallis H test: results expressed as median (IQR)
p-value<0.05 is considered as significant

Table 5 Comparison of anthropometric and physical fitness components among different years of experience

Experience of training	1-5 Years	6-10 Years	11-15 Years	> 15 Years	p-value
Anthropometric					
Weight (kg)	53.4 (13.7)	54.8 (15.7)	63.1 (13.5)	53.5 (30.8)	0.127
Body mass index (kg.m^2)	19.4 (5)	20 (5.4)	22.3 (3.6)	21.4 (13.5)	0.347
Skeletal muscle mass (kg)	24 (6.8)	22.9 (8.5)	26.1 (9.8)	24.8 (6.9)	0.289
Percentage body fat (%)	22.4 (22.4)	25.3 (16.7)	24.1 (21.8)	21.7 (29.5)	0.808
Physical fitness component					
Dominant hand grip strength	26.2 (12.8)	27.9 (11.2)	35.3 (9.3)	38 (20.3)	0.074
1-minute sit-up test	30 (7.5)	30 (11.5)	33 (14)	25 (16.5)	0.652
VO2 peak	58.4 (23.1)	61.7 (26.1)	63.8 (10.9)	65.1 (36.1)	0.474

Krussal Wallis H test: results expressed as median (IQR)

Discussion

This would be the first study looking into the anthropometric and physical fitness components among Malaysian adolescence Karateka. Our age group ranged from 13-19 years old, and the mean weight for our Karateka is lower (59.4 kg±14.3) compared to many international studies. Ravier studied 22 French Karateka, with a mean age of 22±3 years, which had a mean weight of 70.3 kg±3[16]. In Italy, the study by Giampiertro among Italian Karateka, found that 21 amateur Karateka, with a mean age of 21.5±4.5 years, had a mean weight of 69.2 kg±8.9[17]. In Japan, Imamura reported a mean weight of highly competitive black belt Karateka as 66.3 kg±8.2 and a novice group at 60.1 kg±6.9[18]. Rodriguez reported a lower mean weight (50.4 kg±9.2), with a mean age of 13.6±1.86[19] and one study in Malaysia, reported junior Karateka (mean age 21.8±1.6) as having a mean weight of 64.6 kg±8.1[20]; however, this study only looked into 8 male Karateka. When examining anthropometric data in Karateka, it is important to assess the percentage of body fat.

Our mean PBF was higher compared to other studies. In a Malaysian study, junior Karateka had low mean PBF (8%±1.6)[20]. In contrast, the mean PBF among French Karateka was 13.1%±4.4, in the Italian group 11.4%±4.1, and in Japan 10.7%±2 in high levels vs 12.6%±4.5[16–18]. Rodriguez also reported a mean PBF of 15.9±6.9 for their athletes. Although this study exhibited a lower mean weight, our body fat percentages were high. In our study, females had higher PBF compared to males (median=34 vs 17), respectively. The striking gender differences are due to the effect of sex hormones estrogen for females and testosterone for males[21]. These differences can be seen as early as 3–8 years old[22].

Interestingly, among other studies, we reported a comparable mean VO2 peak of 59 ml.kg.min±12.4. The VO2 peak is higher in ages of 18–19 years (p–value=0.186), male Karateka (p–value=0.000), and experienced athletes of >15 years (p–value=0.474). Imamura reported a mean VO2 peak of 59±6.6 in elite Karateka and 57.5±5.2 in novices[18]. Ravier reported a mean VO2 peak of 57.2±4.1 in international level French Karateka[16]. In Malaysia, Najimi reported a mean VO2 peak of 56.6±4.1[18]. When compared to other types of martial arts among the Malaysian population, our Karateka had a higher VO2 peak compared to Silat (36.25±8.5), Muay Thai (40.76±5.48), Boxing (43.44±3.59) and sedentary (29.75±4.02)[12]. This proves our hypothesis that participating in Karate can help increase cardiorespiratory endurance. To the authors knowledge, there are no normative values of VO2 peak among the Malaysian adolescence population. A YOUNG–HUNT study provides a normative value for VO2 peak among normal adolescence aged 13–18 years old Norwegian (male 59.5±9.1 vs female, 49.2±7.1), which showed a higher VO2 peak in males compared to females[23]. This could serve as a normative value for active Malaysian adolescence. Another important finding in our study is that peak oxygen consumption has no direct correlation with increasing age. Thus, it is important to incorporate cardiorespiratory training to improve peak oxygen consumption.

Studies on hand grip strength among adolescence Karateka are limited. Our study demonstrated a lower dominant hand grip strength compared to adult Karateka. Rossi reported mean hand grip strength of right: 46.4 kg±10.2 and left: 43.1 kg±10.4[24]. This study was done among adult Karateka with a mean age of 30.3±8.7[24]. Another study by Wasik, also among adult Karateka, reported a high hand grip strength (right 76.5±21.6 and left 74.5±20.6)[25]: Najmi also reported a higher hand grip strength (39.1±58.4)[20]. When compared to Malaysian adolescence combat sports our hand grip strength was lower compared to Silat (40±8.17), Muay Thai (41.6±5.8), Boxing (49.2±5.2) and sedentary (34.4±10.3)[12]. There are a few hypotheses for this low value. The athletes did not have familiarization with the test; thus, this could be attributed to the low results. We noticed the hand grip strength is higher in the age group of 18–19 years old. That could be associated with higher skeletal muscle mass in this age group. Increasing age has a significant, moderate correlation with increasing strength. The mean age of our study was 15.6±1.8, which could result in lower hand grip strength. More focus should be given to improve hand grip strength during specific training programs.

Another under–explored physical fitness component in Karateka is core strength. One minute sit–up test is the common test used to test for core endurance strength[3]. However, there is no literature that describes the use of this test among Karateka. There was only one study that provided normative value among adolescence[26]. This serves as the baseline for our study to compare. We noticed that our Karateka had higher core endurance strength (males 32±10 and females 27±10.5), compared to the normative value (males 22.2±10.3, females 15.6±8.5)[26].

Kabaday examined the effect of 10 weeks of core training in Karate, and reported improvement balance, reaction time, strength and some Karate-specific techniques[10]. Kamal (2015) examined the effect of core training on skill performance in Karate, and found that it positively affects skill performance among Karate athletes, with a significant difference being reported in the post-test between both groups in the spinning wheel kick assessment (6.50±0.05 vs 5.59±0.06, p-value<0.05)[27]. Strong core muscle function creates a fulcrum for the upper and lower limb strength, allowing cohesion, transmission, and integration between two limbs. Thus, it optimizes the control and transfer of force between two limbs. The core endurance strength in our study was comparable throughout age groups. However, we noticed that as the athletes practice more, the core strength is lower in experienced Karateka as compared to early involvement Karateka. Thus, it is crucial to incorporate core strengthening in Karate training as a new concept of strengthening programs integrated into the training.

This study is a steppingstone study in pediatric sports medicine in Malaysia, as this study focused on a few new things. Firstly, anthropometric and physical fitness assessments in pediatric athletes can be done in the field, require minimal instruments, are cost-effective and having this information will enhance the training programs, so as to tackle lacking components in physical fitness. Our study is also the first study that provides peak oxygen consumption, hand grip and 1 minute sit-up test normative values for ages 13 to 19 years of age. This could serve as a baseline value for reference in the future. However, there are few a limitations in this study. The ideal method to validate our peak oxygen consumption is through cardiopulmonary exercise testing, which would provide a more accurate value. However, the test is expensive and has a high athlete burden. Our test was inexpensive, feasible and practical for field or office assessments. Hand grip strength is used to measure isometric strength. Ideally, strength should be measured in isometric, and isotonic.

Conclusion

This study highlights the baseline anthropometric and physical fitness components among Malaysian adolescence Karateka. Our mean body weight is lower compared to Caucasians but comparable to another Asian country: Japan. The mean BMI in our study was 21.5±4.5 kg.m^2, which falls under normal BMI. The mean VO2 peak was comparable to many international studies (French, Italian and Japanese Karateka) and the Norwegian adolescence population. It demonstrates that Malaysian adolescence Karateka is held to the same standards as our counterparts worldwide. Core endurance strength values were comparable with available normative values. This value serves as a baseline and guide to improve performance among adolescence Karateka in Malaysia.

Authors' contributions

PN, AA, and NAM contributed to the design of the study, data analysis, and manuscript preparation. PN was highly involved in the data collection and NAM supervised the manuscript preparation. All authors have read and approved the final version of the manuscript.

Conflict of interest

There are no potential conflicts of interest to declare.

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