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Anthropometric features and body composition of young athletes practicing karate at a high and medium competitive level

Abstract The aim of the study was to examine the anthropometric features and body composition of athletes practising karate at a high and medium competitive level. Our study was carried out on a sample of 35 subjects practising karate and aged from 16.0 to 32.5 years. This sample was divided into two groups: group 1 (n=14 elite athletes) and group 2 (n=21 amateur athletes). Various anthropometric measurements were taken (weight, height both standing and sitting, diameters, circumferences and skinfold thickness) from which different anthropometric indices were calculated (body mass index, Scelic and Grant indices, arm muscle circumference and area), and the somatotype was then determined. The body composition of each subject was assessed using the skinfold technique and the Jackson-Pollock (J-P) and Sloan-Weir (S-W) equations. The two groups of athletes showed very similar measurements regarding anthropometric characteristics. Only the Scelix index presented a significantly different value in the two groups (49.6±1.3 for group 1 vs. 51.1±1.3 for group 2; p<0.01). Group 1 showed a mesomorphic-ectomorphic somatotype, while the amateur athletes presented a balanced mesomorphic type. Moreover, a lower percentage of fat mass was more frequent in the first group (J-P=8.1±2.4%; S-W=8.9±3.3%) than in the second one (J-P=9.8±1.6%; S-W=11.2±3.7%), although the differences between the two groups were not significant. We conclude that group 1 is characterized by a slightly prominent vertical development of the skeletal frame. This could be an anthropometric characteristic that is best suited to meet the specific functional requirements of this sport. Moreover, both groups of athletes are characterized by a low percentage of fat mass, particularly the elite group.

Key words Karate · Anthropometry · Somatotype · Skinfolds · Body composition

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Introduction

All sports practised at a high professional level require the body to perform at top capacity as far as biomechanics and physiology are concerned. It is therefore logical to expect top-level athletes to have physiques suited to the functional requirements of the sport they practice. As far as karate is concerned, a long-limbed physique is generally considered best suited to the biomechanical characteristics of this sport, thus favoring the selection of athletes with a considerably prominent vertical skeletal development.

Moreover, in sport activities, especially those in which athletes compete in well-defined weight categories, a weight increase due to accumulation of fat may lead to poor athletic performance. Therefore it is important to differentiate between, and assess the amounts of, the two main body components, namely, fat mass (FM) and fat-free mass (FFM) [1].

Over the last few years, karate, like other martial sports, has spread among the young, with the number of athletes rising considerably. Despite this fact, studies regarding the morphological and functional features and the body composition of athletes who practice this composite sport are lacking from the literature.

Therefore, we studied the anthropometric features and body composition of athletes practicing karate at high and medium competitive levels so as to provide a more specific outline of the morphological and functional biotype best suited to the specific technical requirements of this sport.

Subjects and methods

The total sample of subjects (35 healthy men) included the following two groups: (1) 14 subjects (group 1, top-level professional athletes), age 23.8±2.8 years (mean±SD), all athletes of high national and international competitive level who trained 7–9 times per week; (2) 21 subjects (group 2, amateurs), average age 21.5±4.5 years, who had been practicing the sport, on average, from a minimum of 2 to a maximum of 10 years in nine different gymnasiums in Rome, without, however, achieving significant results in this sport, even though they trained 2–6 times per week. Each training session lasted from about 1 h and 30 min to 2 h for all the subjects screened.

Anthropometric measurements

The following measurements were taken by one physician, using conventional criteria and measuring procedures [2]: weight, both standing and sitting height, diameters of the elbow and knee, circumferences of the arm, wrist and calf, and seven skinfolds (biceps, triceps, subscapular, supra-iliac, medial calf, thigh, and chest). All the anthropometric measurements were taken on the left side of the body. Body mass index (BMI) was calculated using the formula: weight (kg)/height^2 (m^2); the Scelic index, i.e., the ratio between the trunk and lower limb length, was calculated using the formula: (sitting height/standing height) x 100, and a constitutional profile of each subject was then drawn accordingly; the Grant index was calculated for each subject according to the formula: standing height (cm)/wrist circumference (cm) [3]. From the arm circumference (AC) and from the corresponding triceps skinfold (TS), the muscle circumference (AMC) and area (AMA) of the arm of the subjects were calculated on the basis of the Gurney and Jelliffe equations [4]. The three components of the somatotype were then calculated according to Heath-Carter equation models [5].

Body composition measurements

Among the many available equations for converting plicometric data into the respective body densities, we used the formula of Jackson-Pollock (J-P) [6], which is frequently used for sportsmen. The equation suggested by Sloan-Weir (S-W) [7] was also used, which proves successful for screening sportsmen. In order to convert body densities into FM percentages, Siri's formula [8] was used.

Statistical analyses

The Student's *t* test for unpaired data was used to identify significant statistical differences between the average values of the various anthropometric and body composition parameters of the two groups. The significance level was *p*<0.05. The "Statview SE+Graphics" statistics software (Abacus Concepts, Inc., Berkeley, CA, USA) was used for all statistical tests.

Results

The anthropometric characteristics of the study participants are shown in Table 1. Group 1 showed a higher average weight (+3.2 kg) and height (+5 cm) than group 2, although the differences were not statistically significant. The BMI value was similar in both groups (Table 2). The average sitting height was identical for both groups (Table 1). The difference between the values of the Scelic index of the two groups was statistically significant (*p*<0.01; Table 2). These data, combined with the identical average sitting height values found in both groups, show a greater frequency of subjects with proportionally longer lower limbs over trunk (long-limbed athletes) in group 1. On the basis of the individual Scelic index values, the number of long-limbed subjects in group 1 was greater than in group 2; only one subject from group 2 turned out to be short-limbed (Table 3). The measurement of the wrist, arm, and calf circumferences revealed no statistical difference between the two groups (Table 1). If the wrist circumference is taken as an index of a subject's skeletal development [9], almost all subjects proved to be of normal-limbed length (Table 3). According to the Grant index values (Table 3), which outline a subject's physical conformation, both groups, on average, could be defined as being of small physical build. The values of the elbow and knee diameter measurements were the same (Table 1). The physical make-up of individual athletes (small, medium, large) from both groups, based on Grant

Table 1 Anthropometric characteristics of the study participants: group 1, elite athletes (*n*=14); group 2, amateur athletes (*n*=21). Values are mean (SD)

	Group 1	Group 2
Age, years	23.8 (2.8)	21.5 (4.5)
Weight, kg	72.4 (8.7)	69.2 (8.9)
Standing height, cm	180 (7)	175 (7)
Sitting height, cm	89 (4)	89 (3)
Circumferences, cm		
Wrist	16.6 (0.8)	16.8 (0.9)
Arm	28.3 (1.4)	28.1 (2.2)
Calf	36.4 (2.5)	37.2 (2.4)
Diameters, cm		
Elbow	6.8 (0.5)	6.8 (0.3)
Knee	9.7 (0.5)	9.7 (0.5)
Skinfolds, mm		
Biceps	3.5 (0.9)	4.0 (1.3)
Triceps	7.8 (2.4)	6.6 (1.9)
Subscapular	9.2 (1.9)	10.3 (4.1)
Supra-iliac *	5.9 (1.8)	10.2 (3.9)
Medial calf	7.7 (2.5)	8.0 (3.0)
Thigh	9.7 (2.6)	11.3 (4.0)
Chest	4.9 (1.5)	5.6 (2.2)

*p<0.001

Table 2 Anthropometric indices of the two groups: group 1, elite athletes (*n*=14); group 2, amateur athletes (*n*=21). Values are mean (SD)

	Group 1	Group 2
BMI, kg/m^2	22.3 (1.7)	22.6 (2.4)
Scelic index*	49.6 (1.3)	51.1 (1.3)
Grant index	10.8 (0.4)	10.5 (0.6)
AMC, cm	25.8 (1.7)	26.0 (2.3)
AMA, cm^2	53.3 (7.0)	54.4 (9.6)

*$p < 0.01$
Scelic index, (sitting height/standing height) x 100; *Grant index*, standing height/wrist circumference; *AMC*, arm muscle circumference; *AMA*, arm muscle area

Table 3 Number and percentage of subjects in the two groups classified in different categories according to the different indices

	Group 1	Group 2
Scelic index		
Long-limbed length	12 (86%)	12 (57%)
Normal-limbed length	2 (14%)	8 (38%)
Short-limbed length	–	1 (5%)
Wrist circumference		
Long-limbed length	1 (7%)	2 (10%)
Normal-limbed length	13 (93%)	19 (90%)
Short-limbed length	–	–
Grant index		
Small	11 (79%)	11 (52%)
Medium	3 (21%)	9 (43%)
Large	–	1 (5%)
Elbow diameter*		
Small	7 (50%)	6 (28%)
Medium	5 (36%)	10 (48%)
Large	2 (14%)	–

*Five subjects from Group 2 below age range

Table 4 The three components of the somatotype. Values are mean (SD)

	Endomorphy	Mesomorphy	Ectomorphy
Group 1	2.1 (0.6)	3.5 (1.0)	3.1 (0.8)
Group 2	2.6 (0.9)	4.2 (1.2)	2.7 (1.2)

Table 5 Fat mass percentage in the two groups assessed using Jackson-Pollock [6] and Sloan-Weir [7] equations. Values are mean (SD)

	Group 1	Group 2
Jackson-Pollock	8.1 (2.4)	8.9 (3.3)
Sloan-Weir	9.8 (1.6)	11.2 (3.7)

index values and on elbow diameter [10], was then compared and some discrepancies emerged (Table 3).

The skinfold thickness values are shown in Table 1. The greatest difference was observed when comparing the supra-iliac skinfold values of the two groups (4.3 mm, *p*<0.001). No significant statistical differences were observed for the other skinfold values. The values of the AMC were similar in both groups, whereas group 2 had a higher average value for AMA than group 1, even though this difference was not statistically significant (Table 2). No statistically significant differences emerged from comparisons between the average values for the three somatotype features of the two groups (Table 4). Mesomorphism was the dominant feature in the group of amateurs, while a higher ectomorphic value was found in group 1 than in group 2. This would seem to indicate greater limb development, as confirmed by the greater height and by the Scelic index values obtained. The average somatotype, therefore, proved to be of a "balanced mesomorphic" kind in the case of the amateurs and of the "mesomorphic-ectomorphic" type in the case of the elite athletes.The percentage of FM found in the two groups resulted in similar mean values, even though in the first group a lower percentage of FM was found, but it was not statistically significant (Table 5).

Discussion

A review of data from the literature revealed some studies conducted on the cardiovascular responses [11, 12] and the energy cost and energy sources [13] during karate kata (forms; pre-determined movement sequences). Others have studied the ballistic movement performance of karate athletes [14]. However, there is a paucity of studies regarding anthropometric and body composition features of karate athletes.

Our study was conducted on 35 subjects practicing karate at medium and high competitive levels. It revealed small differences in physico-constitutional characteristics between top-level professional athletes (group 1) and other karate-practicing male subjects (group 2). On the whole, the subjects in group 1 were taller than those in group 2 and their average limb-to-height ratios were greater, as shown by their Scelic index values. The number of subjects regarded as long-limbed on the basis of the Scelic index was higher in group 1. Even though no statistically significant difference between the two groups was found concerning average values for the various parameters and the body constitution indices, a more slender physique may affect karate performance positively, so that long-limbed and small- to medium-sized subjects are most likely to achieve the best sporting results. The greater development of the vertical physical build of elite athletes was also highlighted by the average somatotype (mesomorphic-ectomorphic) found in group 1 as

compared to that found for amateurs (i.e., balanced mesomorphic). Thus, based on these results we deduce that, body composition of the two groups of athletes practicing karate at a high and medium competitive level was substantially similar. In a study conducted on eight amateur athletes, Francescato et al. [13] found a mean percentage body fat (11.5±4.1%) slightly higher than that for our sample of subjects. On average, both groups in our study were characterized by a low percentage of fat mass, which was, however, lower in the elite athlete group, regardless of the formula used to assess their body composition (Jackson-Pollock or Sloan-Weir).

In conclusion, the dominant anthropometric feature among top-level athletes is a prominent vertical skeletal development rather than a "robust" muscular skeletal system. Although this is only one of the many features capable of playing a significant role in the achievement of top-level results in karate, it is likely that it does represent an advantage for those who practice this sport.

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