ABSTRACT: No study to date, has investigated the physiologic and anthropometric of Iranian elite Karatekas profile. Forty men internationally ranked karatekas in kumite field took part in this study. They were selected for national camp for participation in world karate championships in Germany 2014. The anthropometric and physiological profiles were measured. The major results were as follows: body height (177.9±6.20 kg), weight (72.8±9.98 cm), BMI (23.2±2.36 kg/m2), fat mass (9.5±2.47 kg), lean body mass (64.1±8.89 kg), percentage of body fat (12.9±2.36), sitting height (95.1±4.21 cm), arm span (180.5±7.87 cm), sit and reach (38.7±5.71 cm), pull up (15.7±8.37 rep), shuttle run 4×9 m (8.4±0.28 sec), 40-yd sprint (5.0±0.16 sec), vertical jump Sargent (56.6±8.14 cm), standing broad jump (151.1±13.90 cm), peak power (957.5±164.11 W), anaerobic threshold (165.5±8.05 HR pm) and visual reaction time (378.8±63.82 ms). Significant correlations occurred between peak power with weight, BMI, height, lean body mass, arm span and sitting height (r = 0.75, 0.70, 0.53, 0.77, 0.44, and 0.63, respectively). Also, both arm span and height was negatively correlated to standing broad jump results (r = -0.41 and -0.34, respectively) (p< 0.05).

These anthropometric and physiological profiles from elite Iranian Karatekas can be used in evaluating for talent identification and are important for the optimal construction of training programs the sport scientific, coaches and these athletes.

KEY WORDS: Anthropometric profiles, Physiological profiles, Elite Karatekas, Kumite
Physiological Profile of Elite Iranian Karate

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tactical excellence for success [4, 5]. Karate is confirmed by the millions of people who practice karate worldwide and is one of the most popular sports in Iran as first-rate team in Asian (2012) or super team in the World Champions (2014) and this success reflects a deep-rooted link to this sport among Iranians.

World Karate Federation (WKF) consists of two equally important karate disciplines: the kumite and kata. Kumite is a classical match/combat between two opponents under strict rules using punching, striking and kicking techniques. In contrast, Kata, which means “form,” characterized by individual and team (three athletes) is a set form in pre-established arrangement of aggressive and defensive movements and techniques that are performed with explosive quickness against imaginary opponent [6]. Top-level karate athletes need to have a high fitness levels to perform successfully in top-level competitions and, karate fighting is considered a high-intensity event [7]. According to the WKF, athletes that reach the final must perform one fixed kata styles (Shitei) and one freestyle kata (Tokui) that must have minimum and maximum duration of 60 and 80 s. The time limit of kumite competitions is 3 minutes for male senior athletes and 2 minutes for senior females. The energy systems utilized in karate (kata, kumite) are 50-74 % aerobic, 14-28 % anaerobic alactic and 12-22 % anaerobic lactic [8].

It has been demonstrated that top karateka performance levels essentially related to muscle explosive power and karate final match results are mainly influenced by higher levels of upper and lower limb power production [9]. Flexibility, one of the basic fitness components for sports, is crucial in karatekas to perform high kicks and execute full-range movements at high speeds [6]. Elite male karate athletes are typified by low fat percent (7.5% to 16.8%). The body fat percentage range of top-level male karatekas extends from approximately 16.8% for Polish [10], 13.7% for French elite-level karatekas [11] and 7.5% for Japanese [12]. Giampietro et al. reported that much lower body fat was presented by elite compared with medium level karate athletes [3]. In one study reported that the lean body mass in top-level competitors was higher compared with novice karate competitors [13].

Somatotype combined with physical and physiological fitness capacities, is an indicator of an athlete’s suitability to perform at a top level, when one evaluates the physical characteristics of an athlete. However, the skill, cardiovascular fitness, and psychological profile must also be carefully considered [14, 15]. Some reports revealed that karatekas were more ectomorphic though [3, 16, 17]. Fritzschel and Raschka reported that German elite male karatekas are more ectomorphic than their lower ranked colleagues (2007). In general, top-level male karatekas have high rates of mesomorphic-ectomorphic characteristics and less endomorphic characteristics [6, 18].

Chaabène et al. (2012) in a review article revealed that maximal power, vertical jump performance, maximal power and maximal velocity differed between national- and international level karatekas [6]. It also showed that differences between highly competitive and novice male karatekas in the maximal absolute bench press, half-squat, simple reaction time, one-repetition maximum, performance of isokinetic tasks. Nevertheless, for the maximum accumulated oxygen deficit test there was no difference between them. Polak et al. (2016) examined athletes in 25 different sports and they found that Karatekas were better than athletes in strength of abdominal muscles (1.03), strength of upper limbs, flexibility and running endurance. On the other hand, it has been demonstrated that there are no major anthropometric and physiological differences between karatekas of both kata and kumite.

Comparing aerobic performance of both top-level male and female kata and kumite athletes reported that there was no difference in VO2max relative to body mass between top-level male kata and kumite practitioners [8, 19]. Similar results exist between high-level male kata and kumite karatekas on peak power output [8], agility [19], explosive strength [8] and flexibility [19], however, kumite appears to require a much higher metabolic power than kata, being the energy source with the aerobic contribution predominant [8].

Obviously, high performance athletes require specific physiological profiles with strong psychological traits. Indeed, physical and fitness characteristics of elite athletes are different among various sports and examination of the characteristics of these athletes can help sport scientists and coaches to understand top-level performance by providing information useful in formulating strategies for the explanation and prediction of performance [20]. Even though the number of studies concerning characteristics of elite athletes and talent identification is increasing day by day, there is no consensus on finding the right athlete [1]. In the other hand, assessment of anthropometric and physiological profiles in elite athletes can contribute to talent identification and is important for optimizing training programs to improve elite performance [19]. In karate, researchers indicated a significant relation between anthropometric variables and places won in the championships [6], also, selection of technical actions is related to body build proportions in karate [21]. Therefore, the aim of the present study was to determine anthropometric and physiological profiles of male elite Iranian karate athletes.

METHODS

Subjects

Forty senior male members of the Iranian Karate National Team participated in this study. All participants were internationally ranked kumite athletes, twenty of whom were gold, silver, and bronze medalists in the senior category competing at the Asian and World Championships of 2012–2014.

They all had at least 6 years of training experience. Prior to participation, all participants were informed of the procedures of the
study, completed a pre-test health-screening questionnaire and provided written consent. None of them reported any medical problem or recent injuries that could compromise the tested performance. Ethical approval for the study has been granted by the Review Board University of Tabriz assigned the protocol number: UT1390.

Testing protocol

Measurements took place during the competition phase of the season. To minimize the possible effect of fatigue, all participants were instructed to avoid any strenuous activities three days prior to the experiment and not to exercise on the day of the test. Verbal encouragement was also provided during the testing protocol. All measurements were taken by the same experienced investigators according to standard procedures. The experiment was carried out within a single testing session. It included anthropometric measurements and was followed by physical performance testing.

Body mass and body height were measured to the nearest 100 g and 0.5 cm, respectively. Thereafter, the body mass index was assessed (BMI = body mass / body height 2).

Sitting height and arm’s length extremities were taken. Body fat percent, fat mass and fat free mass was derived from the Jackson–Pollock method (biceps, triceps, subscapular, supra-iliac, medial calf, thigh, and chest) [22]. Siri’s formula was used to convert body densities into fat mass percentages, [23]. These measurements were taken on the right side of the body with the Lange skinfold caliper and obtained on the right side in serial fashion by the same investigator. After the anthropometric measurements were taken, the athletes completed the following experimental tests. Agility was assessed with the shuttle run test (4×9 m). Two 4×9 m run test trails performed, and the quickest time recorded. Explosive power of the leg extensor muscles was estimated by Sergeant jump test. The athletes stranded side on to a wall and reached up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips recorded. The difference in distance between the standing reach height and the jump height was the score. The best of three attempts recorded. This test was presumed validity for the assessment of performance of lower limbs in karate competitors [24]. Athletes were instructed to keep their hands on the hips and to jump as high as possible maintaining the same body position during take-off and landing [9].

Muscular endurance was estimated using the maximal number of pull up (with palms facing the subject). A 40- yd sprint test was used to assess speed. The test involved running a single maximum sprint over 40 yards, with the time recorded. The tester provided hints to maximizing speed and encouraged to continue running hard past the finish line. Flexibility of the trunk was assessed from a sit and reach test using a standard sit and reach box [25]. The score recorded to the nearest centimeter as the distance reached by the hand. Maximal anaerobic peak and mean power output was assessed by 30 seconds of leg cycling (Wingate test). The Wingate anaerobic test has been used to assess the anaerobic profile of karate athletes [8]. Anaerobic threshold was assessed by the Conconi Test through the identification of a coincident deflection in heart rate [26]. The Conconi test as the non-invasive determination of the anaerobic threshold is considered to elite athletes of various sports [27]. Standing broad jump or standing long jump was also used to evaluate leg muscle power [28]. The measurement taken from take-off line to the nearest point of contact on the landing (back of the heels). The best of three attempts (the longest distance jumped) recorded. Visual reaction time was used to evaluate neuromuscular coordination level, as previously been implemented in karate competitors [29].

Statistical analysis

The normality assumption was checked by the Shapiro-Wilk test. All data were subjected to statistical analyses using the Statistical Package for Social Sciences (SPSS v. 19, Inc. Chicago, IL). Pearson correlation was used to examine relationships between variables. The results are reported as means and standard deviations (SD). The level of significance for the alpha was set at 0.05.

**STATISTICAL RESULTS**

All subjects completed the study protocol. Subject descriptive data and anthropometric parameters are shown in Table 1. Participants were 23.79±3.06 years old, had a height average of 177.86±6.20 cm, and a mean body weight of 72.76±9.98 kg. The BMI, fat mass, lean body mass and body fat percent values were 23.17±2.36 (kg/m2), 9.49±2.47 (kg), 64.07±8.89 (kg) and 12.96±2.36, respectively. The mean sitting height and arm span records were 95.13±4.21 and 180.50±7.87 (cm), respectively. The testing results for muscular endurance, anaerobic threshold, anaerobic power, flexibility, agility, reaction time and running speed are presented in Tables 2. The results from the shuttle run 4×9 m and 40- yd sprint showed the mean time as 8.38±0.28 and 4.99±0.16 (sec), respectively. The values of the athletes in the sit and reach, vertical jump Sargent and standing broad jump records were 38.73±5.71, 56.60±8.14 and 151.07±13.90 (cm), respectively. The results from the Conconi Test, which represents an anaerobic threshold, was 165.46±8.05 (heart rate pm). The pull up value was 15.71±8.37 (rep). Wingate test showed a peak, mean and minimum power of 957.47±164.11, 539.94±81.11 and 219.57±58.87 W, respectively. The mean of visual reaction time value was 378.78±63.82 (ms).

Table 3 shows Pearson correlation among anthropometric and physiological characteristics of athletes. Peak power was positively correlated to weight, BMI, height, lean body mass, arm span and sitting height (r = 0.75, 0.70, 0.53, 0.77, 0.47, 0.44, and 0.63, respectively) (p< 0.05). Also, both arm span and height were negatively correlated to standing broad jump results (r = -.41 and -.34, respectively).
Table 1.
Subject descriptive data and anthropometric parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>mean ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>23.79±3.06</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.76±9.98</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.86±6.20</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.17±2.36</td>
</tr>
<tr>
<td>Fat Mass (kg)</td>
<td>9.49±2.47</td>
</tr>
<tr>
<td>Lean body mass (kg)</td>
<td>64.07±8.89</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>12.96±2.36</td>
</tr>
<tr>
<td>Sitting Height (cm)</td>
<td>95.13±4.21</td>
</tr>
<tr>
<td>Arm Span (cm)</td>
<td>180.50±7.87</td>
</tr>
</tbody>
</table>

Table 2.
Physiological scores of athletes

<table>
<thead>
<tr>
<th>Variable</th>
<th>mean ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sit and reach (cm)</td>
<td>38.73±5.71</td>
</tr>
<tr>
<td>Pull up (rep)</td>
<td>15.71±8.37</td>
</tr>
<tr>
<td>Shuttle run 4×9 m (sec)</td>
<td>8.38±0.28</td>
</tr>
<tr>
<td>40-yrd sprint (sec)</td>
<td>4.99±0.16</td>
</tr>
<tr>
<td>Vertical jump Sargent (cm)</td>
<td>56.60±8.14</td>
</tr>
<tr>
<td>Standing broad jump (cm)</td>
<td>151.07±13.90</td>
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<tr>
<td>Wingate test</td>
<td></td>
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<tr>
<td>Peak Power (W)</td>
<td>957.47±164.11</td>
</tr>
<tr>
<td>(W/kg)</td>
<td>13.15±1.79</td>
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<tr>
<td>Mean peak power (W/kg)</td>
<td>539.94±81.11</td>
</tr>
<tr>
<td>Minimum peak power (W/kg)</td>
<td>219.57±58.87</td>
</tr>
<tr>
<td>Anaerobic threshold (heart rate pm)</td>
<td>165.46±8.05</td>
</tr>
<tr>
<td>Visual reaction time (ms)</td>
<td>378.78±63.82</td>
</tr>
</tbody>
</table>

Cm= centimeter; rep= repetition; sec= second; W= watt; pm= per minute; ms= millisecond
Table 3.
Pearson correlation (r) among anthropometric and physiological characteristics of Elite Iranian Karate Athletes

<table>
<thead>
<tr>
<th>Performance</th>
<th>Anthropometric</th>
<th>BMI</th>
<th>Lean body mass</th>
<th>Body fat (%)</th>
<th>Sitting Height</th>
<th>Arm Span</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-.02</td>
<td>-.16</td>
<td>-.13</td>
<td>-.04</td>
<td>-.21</td>
</tr>
<tr>
<td>Pull up</td>
<td>-.28</td>
<td>-.24</td>
<td>-.22</td>
<td>-.25</td>
<td>-.16</td>
<td>-.25</td>
</tr>
<tr>
<td>Shuttle run 4x9 m</td>
<td>-.10</td>
<td>-.09</td>
<td>-.09</td>
<td>-.07</td>
<td>-.18</td>
<td>-.06</td>
</tr>
<tr>
<td>40-50 sprint</td>
<td>-.14</td>
<td>-.18</td>
<td>-.09</td>
<td>-.18</td>
<td>.12</td>
<td>-.21</td>
</tr>
<tr>
<td>Vertical Sargent</td>
<td>jump</td>
<td>.02</td>
<td>.10</td>
<td>.01</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>-.18</td>
<td>-.34*</td>
<td>-.02</td>
<td>.25</td>
<td>.30</td>
<td>-.26</td>
</tr>
<tr>
<td>Wingate test: Peak power</td>
<td>.75*</td>
<td>.53*</td>
<td>.70*</td>
<td>.77*</td>
<td>.05</td>
<td>.63*</td>
</tr>
<tr>
<td>Anaerobic threshold</td>
<td>.03</td>
<td>-.16</td>
<td>.16</td>
<td>.03</td>
<td>-.03</td>
<td>-.09</td>
</tr>
<tr>
<td>Visual reaction time</td>
<td>-.21</td>
<td>-.17</td>
<td>-.18</td>
<td>-.20</td>
<td>-.05</td>
<td>-.09</td>
</tr>
</tbody>
</table>

* p = 0.05
DISCUSSION

Anthropometric measurements of an individual are important asset for several sports, and therefore, considered among the main criteria for success in many sports [30]. Karate training leads to adjustment of physiological and morphological structure complex optimal according to the requirements of this particular sport [31]. Despite the particular popularity of karate, there is a paucity of studies regarding anthropometric and fitness characteristics of karate athletes. To our knowledge, physical and physiological profile nationally and internationally ranked Iranian male karate athletes have not previously been evaluated. Our study was conducted on 40 Iranian Karate National Team members who have competed at the Asian and World Championships.

The mean age of 23.8±3.06 y for males in this study was very close to that reported 23.8 y for the Italian elite Karate athletes [32], and subjects from other study 23.8 y [3]. Also, mean age in this study was partly similar to that reported by Pieter et al. (24.0 y) [16], 24.5 y [33], 24.7 y [34], 22.2 y [2], 23.5 y [5]. As performance in karate requires a balance between the youthful vigor employed in karate training and competition and gain experience, it's suggested that this mean ages are in line with the optimum age for successful performance in karate [35]. These values, however, are lower than 31.6 y [36], 26.7 y [10], 30.7 y [8], and more than 20.7 y [19] and 19.7 y [37].

The stature status in the determination of final success in elite sports has been over-emphasized. It is noted that excessive height is not very beneficial to success in combat sports, including karate [1].

Because muscle strength increases with body size at a lower value than body weight [38], the kata athletes could benefit from a smaller stature. In present study the height values of males karate athletes in kumite field (177.8 cm) were similar to 177.5 cm [37], 176 cm [8] and slightly lower than the 179 cm [10], top-level professional athletes 180 cm [3]. We observed that height values were negatively correlated with standing broad jump. It is suggested that partial shortness versus tall stature has been found to be a particular advantage in rapid change body position, direction, speed of movement and reaction time as demanded by karate [35]. However, height values are higher compared with the subjects from 167.4 cm [36], 169.6 cm [16], 174.3 cm [19] and 172.5 cm [2].

In terms of mean body weight (73.5 kg), there are similarities with the subjects from some other studies 72.4 kg [3], 72.3 kg [32], 71.9 kg , 70.5 kg [19], 70.2 kg [2], but weight value was lower than the 86.1 kg [10] and 78.5 kg [8]; and values were higher than 65.4 kg [36], 64.2 kg [16]. To successful performance in many technical sports such as karate requiring agility, high body weight and percent body fat are not beneficial, as they constitute excess burden and impede physical movements. Studies of male international karate athletes [6] have noted that the range of percentage of body fat values was from 7.5% to 16.8%. In this study the mean fat percentage (12.9) for the karate athletes in kumite field is similar to that reported in other studies [3, 13, 35]. In addition, body mass index (BMI), as an index of weight relative to stature and heaviness, was 23.2 in our study group similar to most previous studies [2, 19, 35, 36]. The values, however, are suggestive of the absence of heaviness and fatness in karate athletes. The positive correlation weight with peak power in this study is similar to that found in other investigations [39, 40]. This may be explained by the fact that an increase in body mass does signify increase in muscle mass, as lean body mass was positively correlated with peak power but no body fat percent. Karate athletes who represented international level had significantly longer experience in karate, greater BMI and lean body mass than those of national sports level [10].

In the karate matches, a high aerobic power is not a guarantee of good results in karate, although aerobic power must be developed to an optimum level to allow the athlete to maintain a high activity level during the whole match without demonstrating excessive fatigue [41]. Moreover, in tournaments where athletes compete in one game after another, well-developed aerobic power is needed for recuperation [1]. However, athletes with a high anaerobic threshold are able to delay the onset of muscle fatigue and generate energy even during high-intensity activities [42]. The anaerobic threshold is a significant indicator for objective assessment of the functional capacity obtained through karate training. The result of Conconi test, as valid and reliable non-invasive measures of the anaerobic threshold [27], showed that heart rate deflection was 165.4 (heart rate per min). To our knowledge, this is the first attempt to characterize the anaerobic threshold of elite kata athletes using the Conconi test. Although this result is appropriate to elite karate athletes, other studies related to water rowing [43] and running [44] have found higher heart rate deflection point. This can be explained by the different type of trainings and athletes in these studies compared to our study.

In karate, obtaining the highest performance level is possible by applying high kinetic energy to one body segment over a short amount of time. Decisive actions in a karate match, a kick or a punch, are dependent on muscle power. Considering that power is the product of force and velocity, higher power represents a higher velocity at the same relative load [9]. Therefore, muscle explosive power plays a major role in achieving top karate performances [6]. Vertical jump test is not special; however it is common used as an excellent indicator of lower limbs power [9]. Greater vertical jump values for international level junior karate athletes has been reported compared to national level athletes [24]. The vertical jump results in our national and international level athletes are higher than those observed in national or international level karate athletes [9, 19, 24, 31]. Standing broad jump was negatively correlated with arm span. It is possible that long arm decreased vertical velocity of at takeoff, which decline jump height [45]. Consequently long arm may be a disadvantage in this situation.
Physiological Profile of Elite Iranian Karate

Although flexibility is crucial in karatekas to perform full-range movements at high speeds [6], limited flexibility becomes unpleasantly obvious, there is little data on the flexibility of karate athletes. The results of the current study, where flexibility was measured using a sit and reach test, were 38.73±5.71 cm and are shown in Table 2. This result is in agreement to those reported in previous research [46] and is higher than the values reported by previous studies [2, 47].

Karate as high-intensity intermittent sport relies mostly on anaerobic energy sources, with determinative actions being a function of explosive movement. Although there no specific test protocol for assessing the anaerobic fitness level of karate athletes [6], the Wingate anaerobic test has been used by previous studies to assess the anaerobic profile of karate athletes. The maximal, mean and minimum anaerobic power of the legs are shown in the Table 2. Maximal anaerobic power values in our study were higher than those of several reports [8, 24, 36, 48, 49], but were lower than results of one study in internationally ranked karate athletes aged 30 [46]. Age difference can be considered as one factor to justification of this result.

Karate is essentially based on explosive techniques and high levels of temporal and spatial constraints, which require high level of perceptual ability and rapid reactions [6]. Reaction time associated with age, is quickest for young adults and can be improved with practice, up to a point, and declines under conditions of fatigue and distraction [29]. The visual reaction time of the athletes was 378.78±63.82 ms in our study group (Table 2). This value is similar to that reported in some studies [2] but was higher than results (293 ± 24 ms) of one report [29]. However, research on reaction time in Karate is scarce and the available literature about both simple reaction time and choice reaction time for karate is controversial [6].

The agility (Shuttle run 4×9 m), pull ups, and 40-yd sprint, values are shown in Table 2. In karate, karateka with potentially above average speed and agility can achieve top results. Indeed, technical efficiency in the karateka is predominantly determined by the abilities of agility [31] and agility is a multi-factorial physical ability affected by explosive strength, speed, balance, muscular coordination, and flexibility [50].

Although studies dealing with agility by Shuttle run 4×9 m test in Karate are scarce, the values recorded in this study were better than observed taekwondo [51] and wrestlers [25] internationally ranked athletes. To date, no data exist to pull ups and 40-yd sprint values in elite karatekas. However, pull ups record was lower and 40-yd sprint values were similar compared with reported by other sports [25, 52].

Conclusion

Very few studies have assessed the anthropometric and physiological characteristics of karate athletes especially kata. The present study is the first description of anthropometric and physical fitness characteristics of male elite karate athletes. These results may have led karate scientists to use physiological and anthropometric measures in talent identification are important for the optimal construction of training programs of the sport scientists, coaches and these athletes. The current study is the first to be published on Iranian National Team. Further research, however, is necessary to validate and identify the most representative tests that focus on athletes’ success within karate either Kata or Kumite.

ACKNOWLEDGEMENT

We thank all of the Iranian National karate who participated in this study.


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47. Yadav S. A comparison between male judo-kas and karate-kas within body composition and physical fitness. Turkish Journal of Sport and Exercise, 2013. 15:3, 64-68


