The value of non-sport-specific characteristics for talent orientation in young male judo, karate and taekwondo athletes

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Abstract

Background & Study Aim: The present study aims to discriminate young male taekwondo, judo, and karate athletes from two age groups. It is hypothesized that a generic test battery (i.e. consisting of non-sport specific items) can allocate athletes in their respective sports. It is also expected that due to training and experience, differences between sports would be larger in the oldest age group.

Material & Methods: Fifty-six highly trained taekwondo, judo, and karate athletes U13 (11.596 ± 0.578 years; n = 30) and U18 (16.097 ± 0.844 years; n = 26) completed five anthropometrical, six physical performance and three motor coordination tests. Discriminant analyses were used to investigate relevant performance measures while MANOVAs were conducted to elucidate the differences between taekwondo, judo and karate.

Results: The classification results for both discriminant analyses U13 and U18 showed a perfect classification (100%) of the athletes in their respective sports. U18 showed higher multivariate differences between the three martial arts i.e. for anthropometrical measures (F2.148, P =0.044, ES =0.36), physical performance characteristics (F2.216, P =0.033, ES =0.43) and motor coordination (F6.697, P <0.001, ES =0.49) when compared to their younger counterparts. Judo athletes had the highest scores for sit and reach, handgrip, counter movement jump and balance beam. While taekwondo athletes had the highest scores for sit-ups, sprint 5m and 30m and jumping sideways.

Conclusions: Generic talent characteristics allow for a successful discrimination between judo, taekwondo and karate athletes, while the differences between the martial arts profiles are more pronounced in older athletes.

Key words: anthropometrical indicators • combat sports • motor coordination tests • Olympic sport • physical performance

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Anthropometrical indicators: Indicators of the body constitution of an athlete.

Combat sports: Competition based martial arts. The combat sports investigated in this article are karate, judo and taekwondo.

Motor coordination tests: Generic performance tests to investigate gross motor coordination and to identify the better movers

Physical performance tests: Generic performance tests to investigate physical characteristics to identify the better-trained athletes.

Olympic sport: Sports discipline scheduled during the Olympic games.

KTK: The "Körperkoordinationstest für Kinder" is a gross motor coordination test battery consisting four subtests.

FSC: The Flemish Sports Compass (FSC) is a multi-dimensional test battery, consisting of anthropometric, physical and motor field tests

Introduction

A variety of performance characteristics and anthropometric characteristics are required for athletes to succeed in a wide range of combat sports. It is however possible, that basic requirements for combat sports are similar. This might allow for a transfer of talent between sports when the desired multi-disciplinary talent characteristics are present. An excellent example is Belgian athlete Catherine Jacques, a multiple national champion and four-time bronze medallist for her category at the European Judo Championships. She was unable to win another medal during the 2004 Summer Olympic podium and instead transferred her talent to ju-jitsu to become the world champion in 2011. Next to the issue of talent transfer, understanding similarities between combat sports might provide talent orientation programs with valuable information when directing young children towards sports that optimally suit their individual profiles. Hence, in countries with a relatively small population where no talent can go to waste, understanding the underlying performance characteristics that relate to international success in karate, judo and taekwondo might help the talent identification as well as the talent transfer process between different combat sports.

In the following overview the key characteristics of karate, taekwondo and judo will be briefly described. First, karate is a martial art characterized by punches of both upper and lower limbs. As such, where competitors use hits with upper and lower limbs [1]. Height and leg length are important talent characteristics, while leg power, core stability and flexibility are basic requirements for kicking [2, 3]. Anthropometric studies revealed that elite karate athletes had a lower fat percentage and longer lower limbs than their peers from other sports [4, 5] Studies investigating performance characteristics elucidated that explosive strength, balance, flexibility and agility contribute to faster executed karate skills [4, 5]. Second, taekwondo is an Olympic sport, which requires explosive strength, flexibility and balance. Height and leg length are essential, while balance, leg power, core stability and flexibility have a beneficial effect on taekwondo performance [6, 7]. Competitors must be able to move with high velocity, speed and power. A surplus of body mass can hinder this ability especially if this excess mass is in the form of fat which is metabolically inactive when compared to muscle [7]. Explosive strength, balance, flexibility and agility contribute to faster and better executed taekwondo skills [6-8]. Third, judo is an Olympic sport classified among the sports that require explosive power of an anaerobic character [9]. It is a high-intensity intermittent, grappling combat sport where athletes are classified by gender and body mass categories [10]. Explosive strength, balance, flexibility and agility contribute to faster judo actions [11,12].

In sum, research using a generic testing battery to reveal performance related characteristics in combat sports showed that height and leg length are important talent characteristics in karate and taekwondo, because leg power, core stability and flexibility are basic requirements for kicking [2, 3, 6, 8]. Explosive strength, balance, flexibility and agility contribute to faster executed taekwondo, judo and karate skills [4-6,11].

Next to the anthropometric and physical characteristics, each of the three combat sports is featured by specific technical skills, the mastery of which requires specific training and a well-developed motor coordination. Previous studies have shown that general motor coordination generally discriminates elite from sub-elite athletes [13]. Given the technical complexity and speed of execution required in martial arts, it is assumed that motor coordination also plays an important role in these sports.

Studies comparing performance characteristics in multiple combat sports are scarce [14, 15] and to our knowledge, no study has compared performance related characteristics in taekwondo, karate and judo specifically. Therefore, this study aims to discriminate young male U13 and U18 athletes from three different combat sports using a generic testing battery. It is hypothesized that young male U13 and U18 from three different combat sports, i.e. taekwondo, karate and judo can be discriminated using a generic test battery. It is also expected that in the oldest age group the differences for the measured talent characteristics would be more pronounced between the sport disciplines due to training and 'natural' selection.

Material and Methods

Participants and design

A sample of 56 highly trained athletes participated in this study and were divided into two age categories: U13: 11.596 ± 0.578 years (n = 30) and U18: 16.097 ± 0.844 years (n = 26). These athletes were participants in karate (n_{U13} = 9; n_{U18} = 6), taekwondo (n_{U13} = 11; n_{U18} = 9) and judo (n_{U13} = 10; n_{U18} = 11). This study has been conducted in accordance with recognized ethical standards in sport and exercise science research [16] and was approved by the local Ethics Committee of the Ghent University Hospital. For all participants written informed parental consent was obtained. None of the participants refused participation.

Measurements

The participants completed five anthropometrical, six physical performance and three motor coordination tests assessed by a team of experienced examiners of the Department of Movement and Sports Sciences, Ghent University (Belgium). At any given time, instruction and demonstration were standardized according to the test guidelines. The athletes performed all tests barefoot with exception of the sprints, the counter movement jump and the endurance shuttle run test, which all were performed with running shoes.

Anthropometry

Height (H) and Sitting Height (SH) (0.1 cm, Harpenden, portable Stadiometer, Holtain, UK), body weight (BW) and body fat percentage (BF) (0.1 kg, Tanita, BC-420SMA, Tokyo, Japan) was assessed according to previously described procedures [17] and manufacturer guidelines. Height and weight values were used to calculate Body Mass Index (BMI).

Physical Performance

Flexibility was assessed by the sit-and-reach test of the Eurofit test battery with an accuracy of 0.1 cm [18]. To assess **explosive leg power**, counter movement jump was performed. The participants performed three single jumps without arm swing recorded with an OptoJump device (MicroGate, Bolzano, Italy). The highest of three jumps was used for further analysis (0.1 cm). **Static strength** was measured by the handgrip [18]. **Speed** was assessed by two maximal sprints of 30 m with split time measured at 5 m. The recovery time between each sprint was set at 2 min. The fastest time for sprint 5 m and for sprint 30 m was used for analysis [19]. The sprint tests were recorded with MicroGate Racetime2 chronometry and Polifemo Light photocells at an accuracy of 0.001 s (MicroGate, Bolzano, Italy). **Upper body strength** was measured through the performance of sit-ups according to the BOT2 procedures [20], requiring the athletes to execute as many repetitions as possible in 30 s.

Motor Coordination

Gross motor coordination was evaluated by means of three subtests of the "Körperkoordinationstest für Kinder" (KTK) [21]. The fourth test hopping for height was not performed, due to risk on injuries at the ankles, cited by Prätorius & Milani [22]. The first subtest assessed the backward balance. Therefore, participants had to walk backwards along balance beams of decreasing width (6 cm; 4.5 cm and 3 cm respectively). Secondly, speed of lower limbs was measured with a two-legged jumping sideways test, performed over a wooden slat (2 x 15 s), summing the number of jumps over the two trials. The third test measured general body coordination. Participants had to move sideways on wooden platforms (2 x 20 s), summing the number of relocations over two trials.

Statistical analyses

All data were analysed using SPPS for Windows (v. 20.0). The present study had a cross sectional design involving two age groups: U13 and U18. First, two canonical discriminant analyses were used to investigate relevant physical performance measures in karate, judo and taekwondo for both age groups. In those analyses, belonging to either of three different sports was the grouping variable and the independent variables were the test results obtained from the five anthropometrical, six physical and three motor coordination characteristics.

Second, Multivariate Analyses of Variance (MANOVA) was conducted to elucidate the differences between taekwondo, judo and karate in two age groups, with anthropometry, physical performance characteristics and motor coordination between karate, judo and taekwondo as fixed factor. In addition, the magnitude of the differences between the levels was estimated using Partial Eta Squared with cut-off scores of 0.01 (small), 0.06 (moderate) and 0.14 (large) [23]. The level of significance was set at $p < 0.05$.

Results

Discriminating between fighting sports

A first discriminant analysis revealed two significant discriminant functions FD1 and FD2 in the U13 sample of young trained male athletes. FD1 (r_{can}=0.954 and Wilks' Λ =0.027 and $p < 0.001$) accounted for 81.4% of the variance between sports participants while FD2 (r_{can} = 0.837 and Wilks' Λ = 0.299 and P = 0.025) reflected 18.6% of the variance. The results also showed that 100% of the athletes were correctly classified in their respective sports. Figure 1 illustrates how well FD1 and FD2 discriminated between each sport in terms of its profile, using the group means of the predictor variables.

The second discriminant analysis also revealed also two significant functions FD1 and FD2 in the sample highly trained male athletes **U18**. FD1 (r_{can} =0.916 and Wilks' Λ =0.048 and P = 0.006) accounted for 69.3% of the variance between sports participants

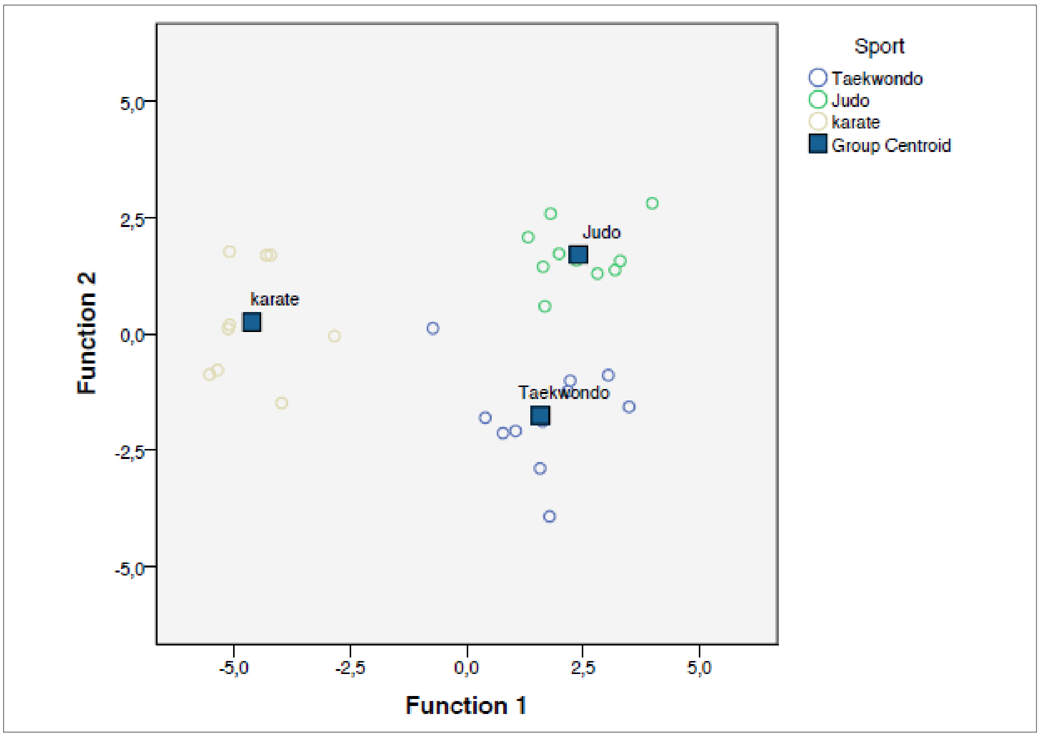

Figure 1. Differences for young trained male athletes U13, based on canonical discriminant functions calculated from the 14 generic tests (FSC).

Note 1. The scatterplot has the canonical discriminant function coefficients as its axes, with Function 1 on the X and function 2 on the Y-axes. The three groups cluster within the 2-dimensional space, indicating that the functions discriminate clearly between judo, karate and taekwondo. The first function on the X-axis was the most helpful in distinguishing between sports with the highest correlation between jumping sideways and DF1. The centroids, which are the mean discriminant score for each group, are indicated by a square.

Note 2. Functions at Group Centroids Karate Function 1 = -4.607; Function 2 = 0.251; Judo Function 1 = -2.405; Function 2 = 1.702; Taekwondo Function 1 = 1.583; Function 2 = -1,753

while FD2 (r_{can} = 0.836 and Wilks' Λ = 0.301 and P = 0.101) reflected 30.7% of the variance. All athletes (100%) were correctly classified in their respective sports. Figure 2 illustrates the differences between each sport for highly trained male athletes U18 based on canonical discriminant functions calculated from the predictor variables.

Identifying relevant talent characteristic for each sport

In the sample young trained male athletes **U13** (11.596 ± 0.578 y) no significant differences in anthropometrical measures ($F_{1.111}$ and P = 0.375, ES = 0.19) occurred. The analysis of physical performance data revealed significant multivariate effects between the three martial arts ($F_{3.208}$ and P = 0.002, ES = 0.47). Post hoc analysis showed that none of the characteristics was significantly different between the three sports. For motor coordination highly significant differences between the martial arts were found ($F_{9.165}$ and P < 0.001, ES = 0.52), Post hoc analysis demonstrated significant differences for jumping sideways ($F_{9.165}$ and P < 0.001, ES = 0.52).

In the highly qualified male athletes **U18** (16.097 ± 0.844 y), a significant main effect of the combat sport discipline for anthropometrical measures ($F_{2.148}$ and P = 0.044, ES = 0.36) was found. However, none of the measures showed significant differences between the three sports in Post Hoc analysis.

The MANOVA on physical performance characteristics resulted in a significant difference between karate, judo and taekwondo ($F_{2.216}$ and P = 0.033, ES = 0.43). Post hoc analyses indicated differences in flexibility ($F_{8.530}$ and P = 0.002, ES = 0.43), static strength ($F_{6.069}$ and P = 0.008, ES = 0.35), upper body strength ($F_{4.521}$ and P = 0.022, ES = 0.28), and speed ($F_{4.445}$ and P

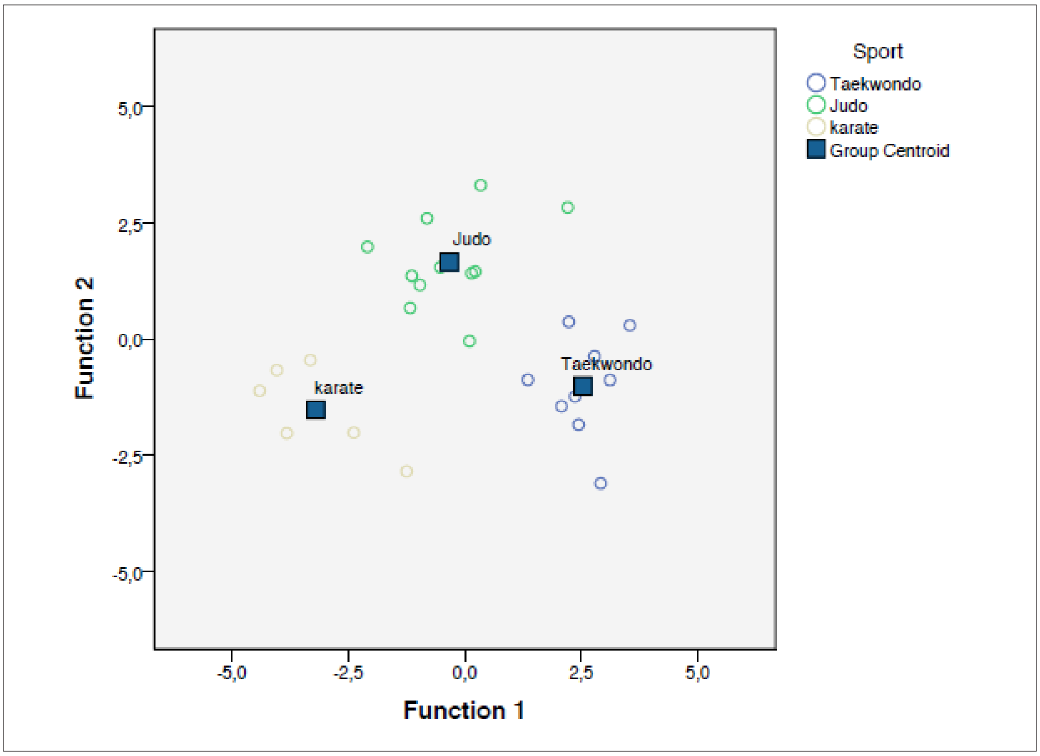

Figure 2. Differences for highly trained male athletes U18, based on canonical discriminant functions calculated from the 14 generic tests (FSC).

Note 1. The scatterplot has the canonical discriminant function coefficients as its axes, with Function 1 on the X and function 2 on the Y-axes. The three groups cluster within the 2-dimensional space, indicating that the functions discriminate clearly between judo, karate and taekwondo. The first function on the X-axis was the most helpful in distinguishing between sports with the highest correlation between jumping sideways and DF1. The centroids, which are the mean discriminant score for each group, are indicated by a square.

Note 2. Functions at Group Centroids Karate Function 1 = -3.197; Function 2 = -1.520; Judo Function 1 = -0.332; Function 2 = 1.657; Taekwondo Function 1 = 2.537; Function 2 = -1,012

= 0.023, ES = 0.28). Finally, highly significant differences for motor coordination were observed between the martial arts ($F_{6.697}$ and P < 0.001, ES = 0.49). Post hoc analysis demonstrated significant differences for balancing backwards ($F_{5.014}$ and P = 0.016, ES = 0.30); jumping sideways ($F_{20.000}$ and P < 0.001, ES = 0.64) and moving sideways ($F_{3.951}$ and P = 0.033, ES = 0.26).

Discussion

The present cross-sectional study investigated to what extent boys U13 and U18 from three different combat sports could be discriminated by a generic test battery and if the differences would be more pronounced in the oldest age group. The main finding was that generic talent characteristics allow for a successful discrimination between judo, taekwondo and karate athletes. In both age groups, 100% of the athletes were correctly classified in their respective sports. Leone and Colleagues [12] reported 86% correct classification for multi-disciplinary talent characteristics in four divergent types of sports i.e. tennis, figure skating, cycling and gymnastics. Discriminating karate, judo and taekwondo might be more problematic due to the similarities between the three martial arts, but the perfect classification rate in our study for both age groups aligned with our hypothesis. According to the second hypothesis, the differences between the martial arts become more pronounced with age. Furthermore, it was found that already before adolescence junior athletes present the necessary anthropometrical, physical and motor coordination characteristics to excel in their sport.

In this study no effect of sports participation on anthropometrical characteristics was found in this U13 sample. In the highly trained U18, multivariate differences between karate, judo and taekwondo

Table 1. Mean (SD) from MANOVAs for young trained male athletes U13 in karate, judo and taekwondo with corresponding F-values, p-values and effect sizes for anthropometry, physical performance, and motor coordination.

	Karate	Judo	Taekwondo	F-value	p-value	Effect Size
	n = 9	n = 10	n = 11			
Age (years)	11.8 (0.7)	11.7 (0.6)	11.3 (0.4)			
MANOVA anthropometry				1.111	0.375	0.19
Body Height (cm)	151.5 (9.3)	148.6 (7.1)	144.3 (8.0)			
Sitting Height (cm)	78.1 (4.3)	77.4 (4.1)	75.8 (3.2)			
Body Weight (kg)	37.3 (7.5)	38.4 (5.3)	36.9 (6.9)			
Body Fat (%)	11.7 (2.3)	12.7 (3.4)	15.1 5.4)			
BMI (kg/m2)	16.1 (1.4)	17.3 (1.9)	17.6 2.2)			
MANOVA physical performance				3.208	0.002	0.47
Sit and Reach (cm)	15.0 (6.5)	18.0 (4.5)	23.5 (3.0)	N.S.		
Hand Grip (kg)	21 (5)	19 (4)	20 (6)	N.S.		
Sit-ups (n/30s)	35 (4)	40 (3)	34 (8)	N.S.		
Counter Movement Jump (cm)	24.2 (4.0)	23.8 (3.8)	22.1 (3.6)	N.S.		
Sprint 5m (s)	1.29 (0.07)	1.32 (0.11)	1.25 (0.06)	N.S.		
Sprint 30m (s)	5.70 (0.41)	5.54 (0.30)	5.38 (0.22)	N.S.		
MANOVA motor coordination				9.165	<0.001	0.52
Balancing Backwards (points)	50 (11)	48 (10)	53 (9)	N.S.		
Jumping Sideways (points)	71 (7)	95 (10)	90 (11)	15.544	<0.001	0.535
Moving Sideways (points)	54 (6)	55 (6)	52 (5)	N.S.		

were found, although post hoc analysis did not reveal anthropometrical differences. The registered differences between the three martial arts in the two age groups are not in line with previous research reporting a leaner body mass and longer legs for karate competitors [4, 5] a larger body length being advantageous for taekwondo athletes [6, 8, 24] and a higher lean body mass in elite judo athletes [25, 26].

In the U13 sample, an overall multivariate effect of sport discipline on physical performance scores was found, although none of the post hoc analyses revealed significant differences. Highly trained adolescents of the U18 group showed multivariate differences between the three martial arts and post hoc analyses demonstrated significant differences for flexibility; static strength; upper body strength speed and coordination with the highest values for sit and reach, handgrip, counter movement jump and balance beam occurring in the judo athletes. The ability to develop a strong grip and to maintain it during a judo match was reported by Franchini et al. [10] and reconfirmed in this study. Agility and explosive strength were linked to judo, support throwing, sweeping and clamping [11, 12]. Leg power, core stability and flexibility have been documented as prerequisites for kicking, in both taekwondo and karate [3, 5, 27]. In the present study taekwondo athletes had the highest scores for sit-ups, sprint 5 m and 30 m and jumping sideways.

General motor coordination has been proven a valuable indicator of an athlete's potential for progression and as such an important talent characteristic in skill-based sports such as artistic gymnastics [13] and combat sports [28]. More-over Krstulovic et al. report that motor coordination and balance is better developed in elite judo and taekwondo athletes compared to non-elite [11]. Our study reinforced these finding showing significant differences in the sample of highly trained athletes for motor coordination between karate, judo and taekwondo.

The athletes that compete in one of both Olympic disciplines (judo and taekwondo) outperformed the Belgian national squad karate for all three motor coordination tests [21]. In the younger age group with trained boys U13, motor coordination differs already

Table 2. Mean (SD) from MANOVAs for highly qualified male athletes U18 in karate, judo and taekwondo with corresponding F-values, p-values and effect sizes for anthropometry, physical performance, and motor coordination.

	Karate	Judo	Taekwondo	F-value	p-value	Effect Size
	n = 6	n = 11	n = 9			
Age (years)	16.0 (1.1)	16.2 (0.8)	16.0 (0.7)			
MANOVA anthropometry				2.148	0.044	0.36
Body Height (cm)	169.9 (10.0)	167.1 8.2)	171.8 (3.8)	N.S.		
Sitting Height (cm)	86.7 (5.6)	88.9 (4.9)	90.7 (2.7)	N.S.		
Body Weight (kg)	57.3 (17.8)	61.4 (7.2)	60.5 (7.2)	N.S.		
Body Fat (%)	10.9 (7.4)	12.9 (2.4)	10.9 (2.1)	N.S.		
BMI (kg/m2)	19.5 (4.3)	21.9 (1.1)	20.5 (2.2)	N.S.		
MANOVA physical performance				2.216	0.033	0.43
Sit and Reach (cm)	17.0 (10.5)	32.0 (7.5)	23.5 (3.0)	8.530	0.002	0.43
Hand Grip (kg)	33 (9)	47 (7)	42 (7)	6.069	0.008	0.35
Sit-ups (n/30s)	38 (7)	44 (4)	49 (8)	4.521	0.022	0.28
Counter Movement Jump (cm)	30.0 (9.3)	33.3 (4)	32.1 (3.7)	N.S.		
Sprint 5m (s)	1.20 (0.09)	1.14 (0.06)	1.11 (0.07)	N.S.		
Sprint 30m (s)	5.05 (054)	4.59 (0.27)	4.54(0.29)	4.445	0.023	0.28
MANOVA motor coordination				6.697	<0.001	0.49
Balancing Backwards (points)	48 (18)	66 (7)	57 (13)	5.014	0.016	0.30
Jumping Sideways (points)	80 (12)	99 (8)	114 (12)	20.000	<0.001	0.64
Moving Sideways (points)	56 (7)	68 (10)	68 (9)	3.951	0.033	0.26

in favour of taekwondo and judo especially for jumping sideways. Those findings are an important indication that it might be important factor in determining who makes it into an expert level in these fighting sports and who does not.

When promoting martial arts, it is important to know that children might choose a sport with different objectives in mind. They can be attracted to different objectives at different points of their engagement with sport [29]. Their engagement to participate can either be recreational or competitive and at the same time one might be a competitive judo athlete and a recreational taekwondo athlete while learning karate. Youth athletes and their trainers, attempting to make it to the top need to be aware of the increasing demands of their sport. Therefore talent identification test batteries are important tools to evaluate if the athlete possesses the necessary talent characteristics and if he or she is still on track. Gulbin et al. found that contrary to a popular pyramidal concept of athlete development a single linear assault on expertise is rare, and that the common normative junior to senior competition transition is mostly characterized by complex oscillations featuring highly varied transitions [29].

The present study focuses on two age groups in which the importance of sport specific characteristics becomes more specific and shifts from motor coordination to more trainable characteristics i.e. speed and flexibility. The special demands that are typical for the training of children and adolescents lead to the question, whether age group training necessitates certain accents in regard to athletic performance in fighting sports. Régnier's sliding population approach [30] take into consideration the different stages of performance and our findings are in accordance with the proposition that anthropometric and physical characteristics become more important as athletes reach a higher level. The strengths of this study include the use of anthropometrical and physical performance characteristics combined with motor coordination tests in different martial arts for different age groups. The limitation of a relatively small sample size is inherent to research in trained athletes, who are not numerous by definition. Nevertheless, generic talent characteristics included in the present study allow for a successful discrimination between judo, taekwondo and karate athletes. If not ignoring the trainers opinion and in addition to an individual screening of performance characteristics, this test battery provides opportunities for talent orientation.

Conclusion

Generic talent characteristics allow for a successful discrimination between judo, taekwondo and karate athletes, while the differences between the martial arts profiles are more pronounced in older athletes.

Competing Interests

Authors declare that we do not have any financial or personal relationships with other people or organisations that could inappropriately influence our paper.

References

1. Sterkowicz-Przybycien KL. Body Composition and Somatotype of the Top of Polish Male Karate Contestants. Biol Sport 2010; 27(3): 195-201
2. Ravier GF, Grappe F, Rouillon JD. Application of force-velocity cycle ergometer test and vertical jump tests in the functional assessment of karate competitor. J Sports Med Phys Fitness 2004; 44(4): 349-355
3. Cesari P, Bertucco M. Coupling between punch efficacy and body stability for elite karate. J Sci Med Sport 2008; 11(3): 353-356
4. Giampietro M, Pujia A, Bertini I. Anthropometric features and body composition of young athletes practicing karate at a high and medium competitive level. Acta Diabetol 2003; 40 Suppl 1: S145-148
5. Imamura H, Yoshimura Y, Uchida K et al. Maximal oxygen uptake, body composition and strength of highly competitive and novice karate practitioners. Appl Human Sci 1998; 17(5): 215-218
6. Marković G, Misigoj-Duraković M, Trninić S. Fitness profile of elite Croatian female taekwondo athletes. Coll Antropol 2005; 29(1): 93-99
7. Kazemi M, Perri G, Soave D. A profile of 2008 Olympic Taekwondo competitors. J Can Chiropr Assoc 2010; 54(4): 243-249
8. Kazemi M, Waalen J, Morgan C et al., A profile of Olympic Taekwondo competitors. J Sports Sci Med 2006; 5: 114-121
9. Cem K, İlknur K, Serpil A et al. The Body composition and some conditional features of women judoists of the Turkish national team. Facta Universitatis. Phys Edu Sport 2010; 8(2): 133-139
10. Franchini E, Del Vecchio FB, Matsushigue KA et al. Physiological Profiles of Elite Judo Athletes. Sports Med 2011; 41(2):147-166
11. Krstulović S, Zuvela F, Katić R. Biomotor systems in elite junior judoists. Coll Antropol 2006; 30(4): 845-851
12. Franchini E, Takito MY, Kiss MAPDM et al. Physical fitness and anthropometrical differences between elite and non-elite judo players. Biol Sport 2005; 22(4): 315-328
13. Vandorpe B, Vandendriessche JB, Vaeyens R et al. The value of a non-sport-specific motor test battery in predicting performance in young female gymnasts. J Sports Sci 2012; 30(5): 497-505
14. Carter J. Size and Somatotype of Olympic Female Athletes at Montreal. Med Sci Sports Exerc 1981. 13(2): 121-144
15. Leone M, Lariviere G, Comtois AS. Discriminant analysis of anthropometric and biomotor variables among elite adolescent female athletes in four sports. J Sports Sci 2002; 20(6): 443-449
16. Harriss DJ, Atkinson G. International Journal of Sports Medicine - Ethical Standards in Sport and Exercise Science Research. Int J Sports Med 2009; 30(10): 701-702
17. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign III; Human Kinetics Books; 1988
18. Council of Europe. Committee for the Development of Sport. EUROFIT: Handbook for the EUROFIT tests of physical fitness. Rome: Secretariat of the Committee for the Development of Sport within the Council of Europe; 1988
19. Matthys SPJ, Vaeyenes R, Vandendriessche J et al. A multidisciplinary identification model for youth handball. Eur J Sport Sci 2011; 11(5): 355-363
20. Bruininks RH, Bruininks BD. Test of Motor Proficiency. Second Edition (BOT-2). Minneapolis: AGS Publishing; 2006
21. Kiphard EJ, Schilling F. Körperkoordinationstest für Kinder. Überarbeitete und ergänzte Auflage. Beltz Test GmbH: Göttingen. Germany; 2007 [in German]
22. Prätorius B, Milani TL. Motorische Leistungsfähigkeit bei Kindern: Koordinations- und Gleichgewichtsfähigkeit: Untersuchung des Leistungsgefälles zwischen Kindern mit verschiedenen Sozialisationsbedingungen. Deutsche Zeitschrift für Sportmedizin 2004; 55(7/8): 172-176 [in German]
23. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Hillsdale: NJ Erlbaum; 1988
24. Chiodo S, Tessitore A, Cortis C et al. Effects of official Taekwondo competitions on all-out performances of elite athletes. J Strength Cond Res 2011.;25(2): 334-349
25. Claessens A, Beunen G, Wellens R et al. Somatotype and Body Structure of World Top Judoists. J Sports Med Phys Fitness 1987; 27(1): 105-113
26. Lech G, Tyka A, Pałka T et al. Effect of physical endurance on fighting and the level of sports performance in junior judokas. Arch Budo 2010. 6(1): 1-6
27. Sadowski J, Gierczuk D, Miller J et al. Success factors in elite WTF taekwondo competitors. Arch Budo 2012. 8(3): 141-146
28. Sadowski J. Dominant Coordination Motor Abilities in Combat Sports. J Hum Kinet 2005; 13: 61-72
29. Gulbin JP, Croser MJ, Morley EJ et al. An integrated framework for the optimisation of sport and athlete development: a practitioner approach. J Sports Sci 2013; 31(12): 1319-1331
30. Régnier G, Salmela JH, Russell SJ. Talent detection and development in sport. In: Singer RN, Murphy M, Tennant LK, eds. Handbook of research on sport psychology. New York: Macmillan Publishing Company; 1993: 290-313

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