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KINESIOLOGY

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Anthropometric profile and anaerobic capacity of martial arts and combat sports athletes

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Key words: taekwon-do, wrestling, anaerobic capacity, anthropometric profile

Abstract

Aim. The aim of the present study was to compare selected anthropometric parameters and anaerobic capacity in representatives of two types of hand-to-hand combat as an example of differences between training in martial arts and combat sports.

Methods. The study included 28 *taekwon-do* athletes (M age = 19.7 yr., SD = 2.21, years of training = 7.9 yr., SD = 1.89) and 28 Greco-Roman wrestlers (M age = 19.0 yr., SD = 1.78, years of training = 6.9 yr., SD = 1.95) at a high competitive national level. Fundamental parameters of anaerobic capacity as well as selected biometric indices were assessed.

Results. *Taekwon-do* athletes demonstrated body mass lower by 5.9% ($p>0.05$) and body height higher by 1.5% ($p>0.05$) than wrestlers. Also, their level of adiposity was lower (by 19.3%, $p<0.05$). Taekwon-do athletes achieved higher values of maximal power (by 1.2 W/kg, $p<0.001$) and total work (by 28.5 J/kg, $p<0.001$).

Conclusions. The type of a hand-to-hand combat requires a different bioenergetic potential and anthropometric profile of competitors.

Introduction

Martial arts and combat sports belong to the same group due to the type of competition even though they constitute two completely different forms of physical activity. Their specificity is manifested through e.g. defining and understanding the basics of a hand-to-hand combat, combat tactics and technique, training methods and traumatism [Donohue, Taylor 1994; Pieter 2005; Zetaruk *et al*. 2005; Vertonghen, Theeboom 2010]. As a result, it should be exemplified in the profile of post-training effects.

Korean *taekwon-do*, similarly to Greco-Roman wrestling, is practised in two forms, both by women and by men, as well as by children, youth and adults. However, these are the only similarities. Differences concerning taekwon-do and wrestling training are manifested in the

domination of other professional coaching activities [Bujak *et al.* 2013; Cynarski *et al.* 2015]. Together with somatic requirements, motor preparation including the shaping of endurance that serves as the basis of performance [Bridge 2014] is also connected with combat specificity.

Anaerobic capacity in combat sports belongs to factors exerting major influence on sports achievements [Fox, Mathews 1981]. The percentage of aerobic and anaerobic capacity in the potential of special capacity is affected by the sports level, age, body mass and the character of combat. Coaches should take into consideration the adjustment of bioenergetic profile of the training to the athlete and sports specialisation [Stone *et al.* 2007]. An appropriate assessment of functional capacities of an athlete makes it possible to select more effective training methods and means depending on the training period and sports level. It prevents discrepancies stemming from performing the training in conditions other than a sports combat [Santos *et al.* 2011]. Thus, in one group of physical activity (direct contact with an opponent) an optimal training should include somatic and motor aspects depending on combat techniques and tactics used.

While searching for objective methods of assessing performance or identifying talents, various methodologies are used [Pankhurst, Collins 2013]. In order to assess bioenergetic potential, laboratory and special tests are used which simulate combat conditions [Kalina *et al.* 2013; Sogabe *et al.* 2015]. The simplicity and measurability of the assessment as well as the precision of applying the loads and registering laboratory tests results are ensured by the standard performance conditions (treadmill, cycling or rowing ergometer). Despite the importance of stamina when preparing for a fight, there has been little research on anaerobic power of taekwon-do athletes [Melhim 2001]. However, more studies examined athletes training Greco-Roman wrestling, freestyle wrestling and women's wrestling [Horswill *et al.* 1992; Hubner-Wozniak *et al.* 2004; Gierczuk *et al.* 2012].

The aim of the present study was to reveal differences between training in martial arts and combat sports by comparing selected anthropometric parameters and anaerobic capacity of taekwon-do athletes and wrestlers.

Material and methods

The research included 28 advanced taekwon-do (ITF) athletes (M age = 19.7 yr., SD = 2.21, years of training = 7.9 yr., SD = 1.89) and 28 Greco-Roman wrestlers (M age = 19.0 yr., SD = 1.78, years of training = 6.9 yr., SD = 1.95). The subjects (males only) were at a high competitive national level (medallists of international competitions and Polish Championships) in similar weight categories who trained 4-5 times a week. The study was conducted during an in-season period. The research protocol was accepted by the local Ethics Commission.

Anaerobic capacity was measured with the 30-second Wingate test on Monark 814 ergometer (Sweden), while data were registered with the MCE 5_ 1 computer software. Prior to the test, subjects performed a 5- to 8-minute warm-up on the ergometer with a sub-maximal load (until they reached the heart rate of 130-150 beats per minute). The load was selected depending on body mass (0.075 g/kg). The software defined two basic parameters, i.e. maximal power (W·kg) and total work (J·kg).

Body height and mass were measured with conventional methods. Body fat (BF) was determined with electrical bioimpedance method (BIA) using body composition analyser Tanita BC-418 MA (Japan).

The results were analysed statistically with the use of basic measurements of location and dispersion and by defining the significance of differences between the examined groups (student's T-test) and correlations between Wingate test indices and other factors (Pearson's correlation) with Statistica 6.0 software. The significance of differences was at the level of $p<0.05$.

Results

Taekwon-do athletes demonstrated body mass lower by 5.9% and body height higher by 1.5% than wrestlers (table 1). The level of adiposity in the group of wrestlers was higher by 19.3% ($p<0.05$) and so was the BMI (by 9%, $p<0.05$).

Table 1. The level of selected anthropometric parameters of the examined athletes

Examined group	Body mass (kg)	Body height (cm)	BF (%)	BMI (kg/m²)
Taekwon-do (n=28)	71.510.5	178.17.16	8.15 ± 3.07	22.472.50
Wrestling (n=28)	76.013.4	175.4 5.42	10.1 ± 4.05*	24.63.3*

* $p<0.05$

Table 2. Values and differences between selected parameters of anaerobic capacity of lower limb muscles in taekwon-do athletes and Greco-Roman wrestlers

Parameter (index)	Taekwon-do	Wrestling	Differences
Max power (W/kg)	11.30.94	10.10.70	1.2 ***
Total work (J/kg)	258.712.53	230.121.36	28.5***

***$p<0.001$

Taekwon-do athletes achieved higher values of maximal power (by 11.9%, p<0.001) and total work (by 12.4%, p<0.001) – table 2.

The correlations between selected parameters of anaerobic capacity of lower limb muscles and anthropometric indices in taekwon-do athletes and wrestlers are presented in tables 3 and 4.

In the examined taekwon-do athletes, maximal power revealed significant correlation (r=-0.44, p<0.01) with body fat, while total work correlated significantly with the BMI (r=-0.44; p<0.01). The remaining correlations were found to be statistically insignificant (p>0.05).

In the group of wrestlers both body height and body fat (BF) correlated significantly with maximal power and total work (table 4).

Correlation coefficients of body height with maximal power and total work were -0.42 and -0.44, respectively (with p<0.01), while in the case of body fat it was -0.38 and -0.46 (with p<0.01).

Discussion

According to various authors [Housh 1997; Heller *et al.* 1998; Gao 2001], basic somatic indices of advanced taekwon-do athletes and wrestlers constitute a group of factors determining a sports success. Taekwon-do athletes and wrestlers have normal body build according to Quetelet I index (QI tkd = 401.5; QI wre = 433.3) and normal body mass according to Quetelet II index (BMI = 18.5 – 24.9). Similar values were found by Heller *et al.* [1998], Lee *et al.* [2012] and Kazemi *et al.* [2009]. The research by Chan *et al.* [2003] proved that sexual dimorphism is visible in the somatotype of elite taekwon-do athletes irrespective of their sports level. According to Gao [2001] and Armstrong [2011], the type of combat sport, sports training and physical effort connected with it differentiate body build of athletes. However, our research on taekwon-do athletes and wrestlers revealed only slight differences concerning basic body build indices. Only the amount of body fat in the total body mass and the BMI were significantly lower (p<0.05) in taekwon-do athletes. Similar results were obtained by Gao *et al.* [1998], who compared advanced taekwon-do athletes with judo and wrestling athletes. Still, it should be highlighted that the division into weight categories is the reason for unnatural loss of body mass in combat sports [Franchini *et al.* 2012]. This, in turn, results in decreasing anaerobic capacity of athletes [Housh *et al.* 1997; Roemmich, Sinning 1997].

The anaerobic capacity indicators obtained by taekwon-do athletes appeared to be significantly different (p<0.001) from the indicators obtained by wrestlers. The research results confirmed the significance of anaerobic capacity in the preparation of elite taekwon-do athletes [Pieter, Heijmans 2000; Bridge 2014]. However, a relatively low level of maximal power (P_{max} = 8.42 ± 0.86 W/kg) of taekwon-do athletes from Taiwan [Lin *et al.* 2006] was not an obstacle for winning medals during the Olympic Games.

The analyses of technical and tactical activities in a combat revealed that non-Olympic taekwon-do athletes perform alternating work, i.e. maximal-intensity efforts (e.g. direct attacks, counter attacks and defence activities) are mixed with lower-intensity strains (preparing an attack, distancing). Therefore, training sessions should be directed at the improvement of the system of anaerobic energy production and aerobic system responsible for the process of compensating energy loss between high-intensity activities [Campos 2012]. Additionally, Markowic *et al.* [2008] and Matsushigue *et al.* [2009] recommended using intensive anaerobic exercises in taekwon-do training, which efficiently improves adaptation to sports combat requirements. Relatively high values of anaerobic capacity indicators of non-Olympic taekwon-do athletes result from a proper selection and rational training work, which is also confirmed by the research of Melhim [2001].

While examining Canadian wrestlers, Schulz [1997] revealed that they may achieve maximal power of 10.78 W/kg. Similar data are provided by Horswill *et al.* [1992], where maximal power was 10.9 W/kg. Slightly higher values than the ones achieved by the subjects of this

Table 3. Correlations between selected parameters of anaerobic capacity of muscles of lower limbs and other indices in taekwon-do athletes

Parameter (index)	Age (years)	Training experience (years)	Body mass (kg)	Body height (cm)	BF (%)	BMI (kg/m²)
Max power	0.25	-0.18	0.13	0.37	-0.44**	-0.08
Total work	-0.16	-0.29	-0.37	-0.06	-0.16	-0.44**

**p<0.01

Table 4. Correlations between selected parameters of anaerobic capacity of muscles of lower limbs and other indices in wrestlers

Parameter (index)	Age (years)	Training experience (years)	Body mass (kg)	Body height (cm)	BF (%)	BMI (kg/m²)
Max power	-0.32	-0.24	-0.15	-0.42**	-0.38**	-0.02
Total work	-0.14	-0.07	-0.37	-0.44**	-0.46**	-0.28

**p<0.01

research were reached by Korean wrestlers (P_{max}=11.2 W/kg) [Yoon 2002] and by Polish elite wrestlers (P_{max} =11.4 W/kg) [Hubner-Wozniak *et al.* 2004]. However, a lower level of maximal power (9.8 W/kg) was noted in the research by Gaces *et al.* [2009].

When comparing the results of the authors' own research to the results of the best wrestlers, 16-percent reserves in anaerobic preparation were revealed. Similar conclusions were made by Borkowski *et al.* [1999], Hubner-Wozniak *et al.* [2004] and Gierczuk *et al.* [2012]. Vardar *et al.* [2007] revealed that contrary to fat tissue, fat-free body mass positively correlates with the maximal power of lower limbs in wrestlers. Similar conclusions were reached by Kim *et al.* [2011] in their research on judo athletes. Our research also confirmed those observations although in the case of taekwon-do athletes they concerned maximal power only.

Taking into account the age of the subjects and their sports level, it seems that training loads are appropriate and are typical of progressive sports development [Stone *et al.* 2007], where the highest results are achieved by senior athletes. Moreover, it should be highlighted that in elite athletes who achieved a particular level of anaerobic capacity this feature does not dominate and is not directly related to the success in combat [Starczewska-Czapowska *et al.* 1999].

In maximal intensity tests, an athlete's motivation to perform such a task is a very significant aspect [Kalina, Barczynski 2008]. In the process of training taekwon-do athletes are taught to accept suggestions of the coach during a combat, and probably they react to verbal motivation more easily and efficiently than wrestlers.

The preparation for sports competitions is often connected with a rapid loss of body mass, usually at a cost of generally-understood health [Tsai *et al.* 2011]; however, it also has positive aspects [Rhyu, Cho 2014]. The lowering of fat-free body mass also decreases the anaerobic work capabilities [Bujak *et al.* 2013], so the preparation period in which the research is carried out may affect the results of athletes.

Conclusions

Taekwon-do and wrestling belong to the same group of sports but they manifest a different potential and anthropometric profile. Taekwon-do athletes are slimmer than wrestlers and they have different body composition and anaerobic capacity level. The type of combat requires different directions of training processes leading to different adaptation. Both groups of the subjects were proved to have reserves in anaerobic capacity, which should be taken into account when planning further training cycles. The results of research on anaerobic capacity ought to be applied to an in-season period and a specific sports level only.

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Profil antropometryczny i wydolność beztlenowa ćwiczących sztuki samoobrony i sporty walki

Słowa kluczowe: *taekwon-do*, zapasy, budowa somatyczna, moc maksymalna

Abstrakt

Cel. Celem badań było porównanie wybranych parametrów biometrycznych i wydolności beztlenowej taekwondzistów i zapaśników, jako efektu wieloletniego i specjalistycznego treningu oraz określenie ich współzależności z innymi wskaźnikami.
Metody. Badaniami objęto zawodników *taekwon-do* ITF w wieku 19,72,21 lat (n=28) oraz zapaśników stylu klasycznego w wieku 19,01,78 lat (n=28). Staż treningowy taekwondzistów wynosił 7,91,89 lat, a zapaśników 6,91,95. Ocenie poddano dwa podstawowe parametry wydolności beztlenowej: moc maksymalną (W·kg) i pracę całkowitą (J·kg) oraz wybrane wskaźniki antropometryczne: wysokość, masę ciała i zawartość tkanki tłuszczowej.
Wyniki. Zawodników *taekwon-do* w porównaniu z zapaśnikami charakteryzowała niższa masa ciała o 5,9% oraz wyższa o 1,5% wysokość ciała. Jednak różnice te nie były istotne statystycznie ($p>0,05$). Poziom otłuszczenia okazał się o 19,3% wyższy w grupie zapaśników względem taekwondzistów ($p<0,05$). Taekwondziści uzyskali w mocy maksymalnej o 11,9% oraz w pracy całkowitej o 12,4% istotnie statystycznie ($p<0,001$) wyższe wartości.
Wnioski. Pomimo zaliczenia *taekwon-do* i zapasów do jednej grupy sportów, zawodnicy prezentują różny potencjał bioenergetyczny i profil antropometryczny determinowany wymogami walki sportowej.