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COACHING

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Body symmetry/asymmetry in youth judokas in the under 73 kg category

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Key words: 3D scanning, anthropometry, combat sports, judo, symmetry, youth

Abstract
Background. The anthropometric status of judokas is most frequently measured in samples containing judokas in all weight categories. It is therefore essential to undertake research into specific weight categories.
Problem and aim. This study seeks to examine the status of body symmetry in youth judokas in the under 73 kg category.
Methods. A group of Slovenian youth judokas (n=10, age: 17.28 ± 1.46 years; height: 177.53 ± 3.71 cm; weight: 73.86 ± 3.01 kg) were recruited for this study. 3D anthropometric measurement of the judokas' bodies was performed by the NX-16 ([TC]^2, 3D body scanner Cary, North Carolina). Using software, we extracted values for 15 paired variables. To determine the differences in symmetries we used a paired T-Test with statistical significance set at $p \leq 0.05$.
Results. In five variables we found statistically significant differences between right and left body pairs. Those were elbow girth $t(9)=4.08$, $p = 0.003$, forearm girth $t(9)=2.84$, $p = 0.019$, thigh girth $t(9)=3.87$, $p = 0.004$, mid-thigh girth $t(9)=5.81$, $p = 0.000$ and calf girth $t(9)=2.45$, $p = 0.037$.
Conclusions. It is of great importance for right hand-stance dominant judokas to train their *nage waza* – throwing techniques – bilaterally to achieve increased technical-tactical solutions in a judo bout and also to develop their morphological characteristics in a symmetrical direction. Those factors will help reduce the dropout rate and will contribute to the systematic and healthy development of youth athletes into competitive senior judokas.

Introduction

There is a need to seek out the most important factors which will enable high level athletes, to achieve their best results [Krzykala 2012]. Among these factors which include the modification of training methods and biological regeneration, a certain level of morphological parameters is also very important. Body compartments, among other factors, play an important role in physical performance [Petersen *et al.* 2006]. The physical constitution of athletes differs, which is reflected in the size and thickness of various parts of the skeleton and in the relationships between them [Garay, Levine, Carter 1974]. Different sports disciplines affect body development and body symmetries in their own individual way; for instance trunk asymmetry has been observed in athletes, body symmetries have been noticed in divers' frontal plane and in young football players pelvis and scapulae symmetry has been observed [Wasik *et al.* 2015].

Various methods are available, to acquire and analyse these result in sports practitioners but they vary depending on the time available for measurement, funds and the accuracy of results [Krzykala 2012]. Nowadays conventional anthropometry is the most widely- known and used method for assessing the dimensions of body segments [Heyward, Wagner 2004], and it is also often used in judo [Franchini, Del Vecchio, Matsushigue, Artioli 2011; Katralli, Goudar 2012; Spieser, Clijsen, Rucker, Cabri, Clarys 2012; Casals *et al.* 2015; Franchini *et al.* 2015;].

The progress of technology and the application of 3D body scanners has taken anthropometric research to a new direction as those methods have become contactless, fast and, above all, accurate [Simmons, Istook

2003; Zhang *et al.* 2014] and are increasingly widely used in judo [Simenko, Vodicar 2015; Simenko 2015a; Simenko 2015b]. Body dimensions are an important component in weight-sensitive sports [Clarys, Geelen, Aerenhouts, Deriemaeker, Zinzen 2011] so a fast and reliable method such as 3D body scanning analysis can also be useful in determining body asymmetries that can lead to the occurrence of injuries [Simenko, Vodicar 2015; Simenko 2015a].

In judo for the most part, the anthropometric status of judokas is measured by a sample including judokas from all weight categories [Katralli, Goudar 2012; Noh, Kim, Kim 2014; Franchini *et al.* 2011; Casals *et al.* 2015]. Therefore some specific morphological characteristics of a particular weight category may not be indicated and are getting lost in an average of all weight categories. Especially in the literature there is a lack of research done on youth judokas in individual weight categories. This present study therefore seeks to examine the status of body symmetry in youth judokas in the under 73 kg category.

Material and methods

Ten youth Slovenian judokas participated in this study, five with 1. DAN and five with 1. KYU belt degree (age: 17.28 ± 1.46 years; height: 177.53 ± 3.71 cm; weight: 73.86 ± 3.01 kg) that are competing in the under 73 kg category in the cadet and/or junior age category in domestic and international tournaments. Two of them were left-hand dominant, and eight of them were right-hand dominant.

3D anthropometric measurement of the judokas' bodies was performed by the NX-16 [[TC]^2 3D body scanner - Cary, North Carolina] that was validated by Simenko, Cuk [2016]. The NX-16 utilizes a non-invasive scanning method to produce a true-to-scale 3D body model in 8 seconds, which uses photogrammetry technology (white light) with 32 cameras to produce raw photonic point cloud data 3D body image. That 3D cloud data image allows for automatic landmark recognition as well as electronic tape measurements. Before measurements, full calibration of the NX-16 scanner was made, with the acceptable range of the accuracy of circumferences standard deviation of 0.577 mm. The subjects were instructed to remove all jewellery and clothes. They entered the scanner barefoot and in form-fitting brightly coloured underwear. They stood in a standardized position, with their feet located on landmarks on the scanner's floor (feet set straight, not inwards or outwards), grabbing the handles inside of the scanner with a natural standing posture (shoulders not elevated, elbows stretched, upright position of the back, chin slightly lifted). A 3D Body Measurement System Version 7.4.1 software was used to create the initial point cloud that was then processed into a 3D body model from which customized measurements could be extracted. A multi-scan option with three consecutive scans was used to obtain the data which gave us one merged file with means of all three consecutive scans. Scanning of three consecutive scans lasted 24 s, and subjects were instructed to be as still as possible. Using software, we extracted values for 15 paired variables: left (L) and right (R) armscye girth, L-R straight

Tab. 1. Paired variables of youth judokas

Variables	Group							
	LEFT		RIGHT		95% CI			
	Mean	**SD**	**Mean**	**SD**	**Lower**	**Upper**	***df***	***t***
Armscye Girth	45,42	1,93	45,38	2,59	-0,79	0,71	9	-0,12
Thigh Length	32,17	2,49	32,26	2,83	-0,20	0,38	9	0,69
Knee Height	48,35	1,59	48,48	1,62	-0,02	0,28	9	2,00
Mid-Thigh Height	64,09	1,90	64,18	1,86	-0,01	0,19	9	2,08
Calf Height	35,46	1,67	36,12	1,45	-0,03	1,35	9	2,16
Outside Leg Length	104,15	3,11	104,25	3,19	-0,03	0,23	9	1,79
Straight Arm Length	57,85	2,06	58,24	1,80	-0,63	1,41	9	0,86
Upper Arm Girth	33,06	1,50	33,27	1,89	-0,44	0,86	9	0,73
Elbow Girth	27,13	1,08	27,76	0,94	0,28	0,98	9	4,08
Forearm Girth	28,42	1,50	28,90	1,38	0,10	0,86	9	2,84
Wrist Girth	17,81	0,65	17,86	0,68	-0,46	0,56	9	0,22
Thigh Girth	57,18	1,67	58,22	1,80	0,43	1,65	9	3,87
Mid Thigh Girth	49,79	1,85	50,95	1,95	0,71	1,61	9	5,81
Knee Girth	38,36	1,38	38,85	1,48	-0,12	1,10	9	1,80
Calf Girth	36,34	1,56	36,88	1,39	0,04	1,04	9	2,45

Source: own research.

arm length, L-R upper arm girth, L-R elbow girth, L-R forearm girth, L-R wrist girth, L-R side height waist to floor, L-R outside leg length, L-R thigh length, L-R thigh girth, L-R mid-thigh height, L-R mid-thigh girt, L-R knee height, L-R knee girth and L-R calf girth. Data were analysed with the SPSS 22.0 software for Windows. To determine the differences in symmetries we used a paired t-Test with statistical significance set at $p \leq 0.05$.

Results

In Table 1 we can see that statistically significant differences were found in 5 out of 15 variables between right and left pairs. Those were elbow girth t(9) = 4.08, p = 0.003, forearm girth t(9) = 2.84, p = 0.019, thigh girth t(9) = 3.87, p = 0.004, mid-thigh girth t(9) = 5.81, p = 0.000 and calf girth t(9) = 2.45, p = 0.037. All of the statistically significant variables were greater on the judokas' right body side. Variables that are not statistically significant, but are closest to the $p \leq 0.05$ limit were knee height t(9) = 2.00, p= 0.077, mid-thigh height t(9) = 2.08, p = 0.068 and calf height t(9) = 2.16, p = 0.059. Also all of the variables that were close to the statistical significance were greater on the right body side. Variables of armscyle girth, thigh length, outside leg length, straight arm length, upper arm girth, wrist girth and knee girth were not statistically significant.

Discussion

The results show that youth judokas in the under 73 kg category statistically differ in 5 out of 15 selected variables and with three variables on the limit of significance. Those results significantly differ from previous study made by Simenko, Vodicar [2015] where they measured 10 judokas from various weight categories and they statistically differed only in one variable: left and right wrist girth t(9) = 2.60, p = 0.03 and with only one variable close to the limit of significance. Therefore, it is important to investigate each individual weight category to highlight potential occurring of asymmetries and determine if they are potentially dangerous or if they maybe correlate with better performance of judokas. In research by Simenko [2015b] it is reported that judokas closer to the directional asymmetry-DA of 0.51 ± 0.09 have greater competition success, but it would be necessary to further research this area on a larger sample of judokas.

From our sample we can see that the majority of our participants was right handed and all of statistically significant differences were greater on the right side. This could be explained that right hand dominant judokas usually fight in the judo bout in a right dominant stance.

Right hand is usually the first one to grab the lapel or sleeve of a *judogi* to start the attack or is the leading-upper arm in the right vs. right stance. Right hand is also the most activated during the *kuzushi* phase where we try to throw off balance our opponent. It looks as if a right hand dominant judokas overload the dominant arm and the effects are evident as a statistically bigger dominant elbow and forearm girt. Similar findings were found in other sports by [Cuk *et al.* 2012] among top level gymnasts. They found statistical differences in forearm girt t = -.640, p = 0.004 and they also connected them to the overloading of the dominant arm with 180.000-200.00 performed gymnastic elements per year.

In this position the right stance dominant judokas usually operate on the left leg as a supporting leg and the right leg is used as the "execution" or attacking leg [Simenko, Rauter, Hadzic 2016]. Right or attacking leg is also positioned closer to the opponent and is therefore more frequently attacked with hooking and sweeping techniques with intention to throw the opponent off balance usually in the right vs. right grip. Therefore, the execution leg is getting much more work than the supporting leg which could lead to imbalance between muscle groups on the left and right body side. They can be expressed in a morphological way, as found in our case in greater right side thigh girth, mid-thigh girth and calf girth, as those muscle groups develop most of the leg movement during attacks.

Results show that, in the under 73 kg weight category, some body asymmetry starts to occur, which can significantly contribute to the occurrence of injuries if they develop excessively. Usually, asymmetry is the consequences of extended lateral training that starts to occur in youth judokas, especially in those that start to compete internationally. Especially if the judokas' training is mostly unilateral and they are performing their throwing techniques only to their dominant side [Simenko 2012] and therefore the dominant side is getting more developed. These circumstances almost always occur when youth judokas are training their *tokui waza* – special technique and/or start they specialization too early. Some morphological asymmetries can later be transformed in functional asymmetries as shown by Simenko, Rauter, Hadzic [2016] on the sample of 5 youth judokas in the under 73 kg category with an isokinetic testing. They found statistical differences in left and right peak eccentric hamstring torque t(4) = -8.77, p = 0.001 and in left and right dynamic control ratio-DCR t(4) = -3.85, p = 0.018. Research suggests that the high focus should be put on the eccentric hamstring strength of the supporting leg to prevent possible occurrence of injuries when attacked by e.g. *uchi-mata* and to lower the bilateral strength asymmetry which was 18.85 ± 6.24 % for the eccentric hamstring contraction.

Coaches of youth judokas that are starting to develop their *tokui waza* should enforce the development of the bilateral execution of those techniques to increase the motor efficiency of judokas and consequently increase

their technical-tactical solutions in a fight and, especially, to reduce the possibilities of injuries occurring. Especially if we know from the research by Sterkowicz, Lech, Blecharz [2010] that laterality of upper and lower limbs shows significant correlation with the choice of dominant directions of attack in judo fight. Research shows that left-sided athletes show significantly better chances of winning medals compared to their right-sided counterparts, therefore it should be important for right-sided judokas to improve and execute more their left side throws.

Conclusion

It is of great importance for right hand-stance dominant judokas to train their *nage waza* – throwing techniques, bilaterally to achieve increased technical-tactical solutions in a judo bout and also to help in a symmetrical development of their morphological characteristics. All previously listed factors will help reduce the dropout rate and contribute to a systematic and healthy development of youth athletes into competitive senior judokas.

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Symetria i asymetria ciała judoków w kategorii juniorów do 73 kg

Słowa kluczowe: skanowanie 3D, antropometria, sporty walki, *judo*, symetria, młodzież/juniorzy

Abstrakt

Tło/perspektywa. Status antropometryczny judoków jest głównie mierzony w grupie ankietowanych obejmującej judoków ze wszystkich kategorii wagowych, w związku z tym konieczna jest analiza indywidualnej kategorii wagowej.
Problem i cel. Niniejsze opracowanie ma na celu zbadanie stanu symetrii ciała judoków w kategorii juniorów w wadze do 73 kg.
Metody. W badaniu brali udział młodzi słoweńscy judocy (n = 10, wiek: 17,28 ± 1,46 lat; wzrost: 177.53 ± 3,71 cm; waga: 73,86 ± 3,01 kg). Antropometryczny pomiar ciała judoków został przeprowadzony przy użyciu skanera ciała 3D NX-16 ([TC]^2. W celu określenia różnic w symetrii użyto sparowanego T-Testu z istotnością statystyczną zmiennych na poziomie $p \leq 0.05$.
Wyniki. W pięciu zmiennych znaleziono statystycznie istotne różnice między prawymi i lewymi częściami ciała np. obwód łokcia t (9) = 4,08, p = 0,003, obwód przedramienia t (9) = 2,84, p = 0,019, obwód uda t (9) = 3,87, p = 0,004, obwód w połowie uda t (9) = 5,81, p = 0,000 i obwód łydki t (9) = 2,45, p = 0,037.
Wnioski. Ogromne znaczenie dla judoków o dominującej prawo-stronnej postawie ma szkolenie techniki rzucania *nage-waza* dwustronnie dla zwiększenia rozwiązań techniczno-taktycznych w walkach judo, a także by symetrycznie rozwijali swoje cechy morfologiczne. Czynniki te pomogą zmniejszyć wskaźnik przerywania treningu judo i przyczyniają się do systematycznego oraz zdrowego rozwoju zawodników juniorów w judoków seniorów.