Somatotypes of elite male and female junior sambo athletes

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C Statistical Analysis
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Abstract

Background and Study Aim: Sambo is a relatively novel international martial art founded back in the 1930's. It is mainly characterised by specific throws, holds, arm and leg locks, where successful performance depend on a specific technique and tactical skills along with optimal physical fitness. The aim of the present study was somatotype and anthropometric profiles of elite junior sambo athletes divided by weight categories.

Material and Methods: A total of 156 elite junior sambo athletes from 34 countries participants of the World Youth and Junior Sambo Championships participated in the study (52 females and 104 males from 10 weight categories). Anthropometrical variables were taken in order to calculate somatotypes. A one-way analysis of variance and Tukey's post hoc test were used to compare groups by weight categories and effect sizesη22 were calculated as well.

Results: Results of this study provide the first description of the anthropometrical profile and somatotype of elite male and female junior sambo athletes. A typical somatotype in male sambo athletes was endomorphic mesomorph with indicating a predominance of musculoskeletal tissue, while female athletes were classified as endomorphic mesomorph and mesomorphic endomorph in relation with weight division.

Conclusions: This study highlights the importance of distinguishing between categories during the training and selection processes since sambo athletes have a specific body composition in function of the weight category in which they compete.

Keywords: anthropometric profile • martial arts • skinfolds • somatochart • weight categories

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Martial arts – are any of several arts of combat and self-defence (such as sambo) that are widely practised as a sport.

Skinfolds – is a fold of skin and its underlying adherent subcutaneous tissue.

Weight categories – are divisions used to match competitors against others of their own weight.

Somatochart – A diagram that can be used to display the somatotype of an individual or group.

Anthropometric profile – refers to comparative measurements of the body.

INTRODUCTION

Qualification and determination of elite athletes can provide insightful information regarding to competitive success. In combat sports, structurally similar to sambo, special attention has been paid to the morphological characteristics of elite athletes [1-6]. However, there is no available study about body composition and somatotypes of sambo athletes. Sambo is a relatively novel international martial art founded back in the 1930's. It is mainly characterised by specific throws, holds, arm and leg locks, where successful performance depend on a specific technique and tactical skills along with optimal physical fitness [7]. During a high-intensity action in sambo, the opponents are trying to throw each other predominantly on the back or to control the opponent during the ground phase [7, 8].

Sambo competitions are divided according to age and weight category. Therefore, based on age and weight category sambo athletes need to control body mass in order to select the best category that suits them. Research has shown that combat athletes usually try to maximise muscle mass and to minimise adiposity in each weight category, with an attempt to increase power-body mass ratio. This process starts in early adolescence in both genders [9]. However, negative consequences due to rapid weight loss are not rare [10].

Previous research points out on differences in anthropometrical characteristics of combat athletes due to numerous factors, including competition level, weight category, experience, gender and age [8, 11-13]. Also, there are relationships between somatotype and the level of sports achievement in martial arts [14]. The authors found key factors which determine champion levels, emphasising the importance of somatic build for specialisation in sport [15]. Also, differences in somatotype between males and females have consistently been found in both the general and athletic populations with the males being more mesomorphic and the females having a higher endomorphy rating.

Determination data which allow identification and classification of somatic build in elite sambo athletes will contribute in development a model necessary for success in sambo sport. Such information may also be useful and serve as an indicator of the minimum fitness standards required to compete in sambo on high levels. Since body composition, as well as certain somatotype of athletes, can determine success in combat sports, our study will provide useful information in this field regarding to sambo. Concerning this fact, the aim of this study was the somatotype and anthropometric profiles of elite junior sambo athletes divided by weight categories.

MATERIAL AND METHODS

Subjects and design

The sample was composed of 104 male sambo athletes (age 19.8 ±3.7 years) and 52 female sambo athletes (age 17.7 ±1.4 years). All testing procedures were conducted during the World Youth and Junior Sambo Championships held in Novi Sad (Serbia). Participants were divided into ten male and female official weight categories (male for –48 kg, –52 kg, –57 kg, –62 kg, –68 kg, –74 kg, –82 kg, –90 kg, –100 kg +100 kg, female for –44 kg, –48 kg, –52 kg, –56 kg, –60 kg, –64 kg, –68 kg, –72 kg, –80 kg, +80 kg). All participants took part voluntarily in the study. Informed written consent was obtained from each subject, and all procedures were performed in accordance with the Declaration of Helsinki. The study was approved by the local institutional review board (IRB).

Anthropometrical measurements

Following anthropometric measurements were conducted: height and body mass, four skinfolds (triceps, subscapular, supraspinale, calf), breadths (humerus and femur diameters), girths (arm and calf), breadths (humerus and femur diameters). Body height was determined using a Martin anthropometer (GPM, Switzerland), skinfolds were measured using a John Bull caliper (British Indicator Ltd, UK) accurate to 0.2 mm, girth measurements were acquired with a steel measuring tape, and wrist girth and bicondylar diameters of the femur and humerus were measured using a small spreading caliper (SiberHegner, Switzerland).

Statistical Analysis

Data are presented as the mean and standard deviation (±). The Levene's test was used to access the equality of variances. A one-way analysis of variance and Tukey's post hoc test were used to compare groups by weight categories and effect sizes η2 were calculated as well. The level of significance was set at 5%. All analyses were conducted using SPSS statistics software.

RESULTS

Male sambo athletes did not have either one participant from the lightest weight category according to sambo rules (<48 kg). First three weight categories showed differed height across non-subsequent weight categories. Athletes from first four weight categories were different generally compared with the four heaviest in all four skinfolds. Exceptions are in triceps and calf skinfolds where differences were not found between −100 kg weight category with any of lighter or >100 kg group (Table 1).

Statistically significant differences in humerus breadth were only found between two lighter categories and -90 kg. Otherwise, in femur breadth differences were more often. Namely, athletes from first three weight categories were different from −82 kg, −90 kg and >100 kg, -68 kg were different compared with -90 kg and >100 kg, −74 kg with −62 kg and >100 kg. Groups −100 kg and >100 kg were significantly different as well. Concerning arm girth, it could be concluded that athletes were always different compared with non-subsequent weigh categories, i.e., 52 kg with 8 heaviest groups, −57 kg with 7, etc. The second girth showed differences between the three lightest and four heaviest groups. Middle group (−68 kg) were different compared with two lightest and two heaviest groups. Somatotype differences between weight categories were not found (Table 1).

Female sambo athletes from three lightest weight categories were significantly smaller than athletes from three heaviest groups. Also, participants from the first category were different

Table 1. Differences between weight categories of male sambo athletes (mean and standard deviation).

Variable	−48^{a} (n=0)	−52^{b} (n = 9)	−57^{c} (n = 12)	−62^{d} (n = 17)	−68^{e} (n = 19)	−74^{f} (n = 13)	−82^{g} (n = 18)	−90^{h} (n = 9)	−100^{i} (n = 4)	>100^{j} (n = 3)	Statistics
Height (cm)	-	161.21 ±2.79 ^{d,e,f,g,h,i,j}	167.14 ±2.29 ^{e,f,g,h,i,j}	170.88 ±4.27 ^{b,g,h,i,j}	175.48 ±4.57 ^{b,c,i}	175.77 ±4.62 ^{b,c,i}	178.67 ±6.10 ^{b,c}	180.24 ±5.80 ^{b,c,d}	184.70 ±4.21 ^{b,c,d,e,f}	183.00 ±3.61 ^{b,c,d}	F = 21.86, P =0.000, $\eta^2 = 0.65$
Skinfolds											
Triceps (0.1 mm)	-	6.02 ±1.55 ^{g,h,j}	6.32 ±1.22 ^{g,h,j}	6.11 ±1.81 ^{g,h,j}	6.63 ±1.24 ^{g,h,j}	8.29 ±2.73 ^{h,j}	9.57 ±2.63 ^{b,c,d,e}	12.04 ±4.76 ^{b,c,d,e,f}	8.95 ±4.55	14.33 ±4.04 ^{b,c,d,e,f}	F = 9.55, p = 0.000, $\eta^2 = 0.45$
Supraspinale (0.1 mm)	-	6.40 ±1.68 ^{g,h,i,j}	6.18 ±1.82 ^{g,h,i,j}	8.11 ±3.95 ^{g,h,i,j}	7.95 ±2.41 ^{g,h,i,j}	9.23 ±4.11 ^{h,i,j}	14.13 ±7.61 ^{b,c,d,h,j}	23.78 ±8.77 ^{b,c,d,e,f,g}	20.50 ±2.89 ^{b,c,d,e,f}	28.67 ±5.13 b,c,d,e,f,g	F = 19.47, p = 0.000, $\eta^2 = 0.62$
Subscapular (0.1 mm)	-	7.40 ±1.34 ^{g,h,i,j}	7.52 ±.89 ^{g,h,i,j}	8.25 ±2.11 ^{g,h,i,j}	8.74 ±1.38 ^{g,h,i,j}	9.92 ±2.02 ^{h,i,j}	12.57 ±4.55 ^{b,c,d,e,h,j}	17.49 ±5.52 ^{b,c,d,e,f,g}	16.75 ±2.99 ^{b,c,d,e,f}	21.67 ±1.53 ^{b,c,d,e,f,g}	F = 20.50, p = 0.000, $\eta^2 = 0.63$
Calf (0.1 mm)	-	5.40 ±1.58 ^{g,h,j}	6.03 ±1.49 ^{g,h,j}	6.35 ±1.90 ^{g,h,j}	6.65 ±1.69 ^{g,h,j}	7.63 ±2.10	9.56 ±4.06 ^{b,c,d,e}	10.61 ±3.14 ^{b,c,d,e}	8.85 ±3.94	12.33 ±4.62 b,c,d,e	F = 6.18, p = 0.000, $\eta^2 = 0.34$
Breadths											
Humerus (mm)	-	6.81 ±.56 ^{h}	6.87 ±.32 ^{h}	7.21 ±.88	7.22 ±.38	7.42 ±.63	7.33 ±.57	7.76 ±.51 ^{b,c}	6.73 ±1.16	8.07 ±.59	F = 3.15, p = 0.003, $\eta^2 = 0.21$
Femur (mm)	-	9.16 ±.38 ^{f,g,h,j}	9.27 ±.29 ^{g,h,j}	9.31 ±.77 ^{f,g,h,j}	9.97 ±.45 ^{h,j}	10.12 ±.53 ^{d,j}	10.36 ±.70 ^{b,c,d,j}	10.86 ±.49 ^{b,c,d,e}	9.75 ±1.95 ^{j}	11.87 ±1.70 ^{b,c,d,e,f,g,i}	F = 10.33, p = 0.000, $\eta^2 = 0.47$
Girths											
Arm (cm)	-	28.49 ±2.13 ^{d,e,f,g,h,i,j}	30.55 ±2.50 ^{e,f,g,h,i,j}	31.62 ±1.58 ^{b,f,g,h,i,j}	33.12 ±1.77 ^{b,c,g,h,i,j}	34.24 ±1.08 ^{b,c,d,g,h,i,j}	36.66 ±1.56 ^{b,c,d,e,f,h,i,j}	36.90 ±1.74 ^{b,c,d,e,f,i,j}	39.73 ±.53 ^{b,c,d,e,f,g}	43.23 ±1.78 ^{b,c,d,e,f,g,h}	F = 45.94, p = 0.000, $\eta^2 = 0.80$
Calf (cm)	-	32.12 ±.87 ^{f,g,h,i,j}	32.95 ±1.27 ^{e,f,g,h,i,j}	33.93 ±1.21 ^{f,g,h,i,j}	36.21 ±1.92 ^{b,c,i,j}	37.15 ±1.03 ^{b,c,d,j}	36.91 ±5.16 ^{b,c,d,j}	38.61 ±1.63 ^{b,c,d}	41.25 ±1.50 ^{b,c,d,e}	43.00 ±2.65 ^{b,c,d,e,f,g}	F = 12.84, p = 0.000, $\eta^2 = 0.52$
Somatotypes											
Endomorphy	-	3.51 ±1.39	2.47 ±1.15	3.29 ±1.35	2.86 ±1.12	2.97 ±1.50	2.75 ±1.11	3.17 ±1.17	3.12 ±1.34	4.10 ±1.29	F = 0.81, p = 0.596, $\eta^2 = 0.70$
Mesomorphy	-	5.60 ±1.37	5.03 ±.78	5.11 ±1.05	4.84 ±1.29	5.52 ±1.90	5.10 ±1.55	5.25 ±1.45	5.66 ±2.69	5.70 ±.89	F = 0.40, p = 0.918, $\eta^2 = 0.04$
Ectomorphy	-	2.23 ±1.33	2.61 ±.97	2.42 ±1.00	2.40 ±1.03	2.07 ±1.34	2.19 ±.90	2.00 ±.63	1.91 ±1.66	1.39 ±.80	F = 0.57, p = 0.800, $\eta^2 = 0.05$

different from: **a** −48 kg; **b** −52 kg; **c** −57 kg; **d** −62 kg; **e** −68 kg; **f** −74 kg; g = −82 kg; **h** −90 kg; **i** −100 kg; **j** >100kg.

Table 2. Differences between weight categories of female sambo athletes (mean and standard deviation).

Variable	-44^{a} (n = 5)	-48^{b} (n = 5)	-52^{c} (n = 5)	-56^{d} (n = 10)	-60^{e} (n = 12)	-64^{f} (n = 6)	-68^{g} (n = 3)	-72^{h} (n = 2)	-80^{i} (n = 2)	$>80^{j}$ (n = 2)	Statistics
Height (cm)	$153.54 \pm 4.43^{d,e,f,g,h,i,j}$	$156.14 \pm 2.04^{e,h,i,j}$	$156.34 \pm 3.29^{e,h,i,j}$	$161.96 \pm 3.68^{a,i}$	$164.40 \pm 4.78^{a,b,c}$	163.25 ± 2.75^{a}	164.77 ± 9.55^{a}	$172.25 \pm 3.18^{a,b,c}$	$173.10 \pm .14^{a,b,c,d}$	$170.00 \pm 1.41^{a,b,c}$	$F = 8.63$, $p = 0.000$, $\eta^2 = 0.65$
Skinfolds											
Triceps (0.1 mm)	10.80 ± 2.39^{j}	9.00 ± 2.92^{j}	12.64 ± 2.86^{j}	12.60 ± 2.76^{j}	14.18 ± 4.59^{j}	13.73 ± 2.58^{j}	16.33 ± 2.52^{j}	18.50 ± 6.36	$16.70 \pm .99^{j}$	$30.50 \pm 9.19^{a,b,c,d,e,f,g,i}$	$F = 6.82$, $p = 0.000$, $\eta^2 = 0.59$
Supraspinale (0.1 mm)	10.20 ± 4.92^{j}	10.80 ± 3.35^{j}	13.12 ± 2.09^{j}	13.56 ± 6.38^{j}	16.68 ± 6.74^{j}	15.57 ± 3.61^{j}	19.67 ± 11.50^{j}	22.50 ± 7.78	$15.50 \pm .71^{j}$	$40.50 \pm 12.02^{a,b,c,d,e,f,g,i}$	$F = 5.18$, $p = 0.000$, $\eta^2 = 0.53$
Subscapular (0.1 mm)	7.64 ± 1.77^{j}	8.72 ± 2.28^{j}	11.20 ± 2.28^{j}	9.46 ± 2.19^{j}	11.58 ± 3.61^{j}	11.77 ± 1.42^{j}	12.83 ± 4.25^{j}	$15.60 \pm .85^{j}$	$13.50 \pm .71^{j}$	$41.00 \pm 11.31^{a,b,c,d,e,f,g,h,i}$	$F = 21.68$, $p = 0.000$, $\eta^2 = 0.82$
Calf (0.1 mm)	10.40 ± 3.97^{j}	$8.32 \pm 3.18^{h,j}$	10.52 ± 6.55^{j}	13.54 ± 3.02^{j}	13.32 ± 4.95^{j}	13.33 ± 4.84^{j}	15.00 ± 10.15^{j}	23.70 ± 2.40^{b}	16.00 ± 8.49^{j}	$40.50 \pm 12.02^{a,b,c,d,e,f,g,i}$	$F = 7.56$, $p = 0.000$, $\eta^2 = 0.62$
Breadths											
Humerus (mm)	$5.30 \pm .57$	6.10 ± 1.28	$5.16 \pm .79$	$6.12 \pm .49$	6.04 ± 1.06	$5.43 \pm .87$	$6.60 \pm .26$	$5.80 \pm .42$	$6.10 \pm .57$	$6.45 \pm .64$	$F = 1.40$, $p = 0.220$, $\eta^2 = 0.23$
Femur (mm)	$7.96 \pm .63^{i,j}$	$7.42 \pm 1.44^{d,e,i,j}$	$8.14 \pm .89^{i,j}$	$8.94 \pm .60^{j}$	$9.02 \pm .82^{b,j}$	8.38 ± 1.14^{j}	$9.77 \pm .46^{b,j}$	$9.70 \pm .28^{j}$	$10.55 \pm .78^{a,b,c}$	$13.20 \pm .42^{a,b,c,d,e,f,g,h}$	$F = 9.78$, $p = 0.000$, $\eta^2 = 0.68$
Girths											
Arm (cm)	$27.10 \pm 2.30^{f,g,h,i,j}$	$27.20 \pm .45^{f,g,h,i,j}$	29.60 ± 1.14^{j}	$28.75 \pm .92^{j}$	30.00 ± 1.35^{j}	$30.70 \pm 1.74^{a,b,j}$	$32.17 \pm .29^{a,b,j}$	$32.50 \pm 2.12^{a,b,j}$	$32.00 \pm 1.41^{a,b,j}$	$44.00 \pm 7.07^{a,b,c,d,e,f,g,h,i}$	$F = 19.42$, $p = 0.000$, $\eta^2 = 0.81$
Calf (cm)	$31.30 \pm 1.30^{e,f,g,h,i,j}$	$32.40 \pm 1.67^{f,g,h,i,j}$	$33.80 \pm 1.48^{f,h,i,j}$	$33.40 \pm 1.91^{f,h,i,j}$	$34.75 \pm .99^{a,i,j}$	$37.08 \pm 1.50^{a,b,c,d,j}$	$36.33 \pm 1.15^{a,b,j}$	$38.25 \pm 1.77^{a,b,c,d,j}$	$40.50 \pm .71^{a,b,c,d,e,j}$	$49.50 \pm .71^{a,b,c,d,e,f,g,h,i}$	$F = 35.27$, $p = 0.000$, $\eta^2 = 0.88$
Somatotypes											
Endomorphy	$3.67 \pm .84$	$2.57 \pm .73$	3.93 ± 1.50	2.76 ± 1.04	3.38 ± 1.18	2.79 ± 1.42	$5.27 \pm .99$	3.30 ± 1.30	3.52 ± 1.41	3.40 ± 2.09	$F = 1.65$, $p = 0.136$, $\eta^2 = 0.28$
Mesomorphy	5.44 ± 1.79	5.14 ± 2.14	4.61 ± 1.56	4.59 ± 1.38	5.00 ± 1.42	$5.55 \pm .45$	5.15 ± 1.85	5.79 ± 1.62	$3.46 \pm .31$	4.37 ± 3.12	$F = 0.54$, $p = 0.835$, $\eta^2 = 0.11$
Ectomorphy	$2.07 \pm .71$	2.06 ± 1.21	1.89 ± 1.15	$2.76 \pm .74$	2.07 ± 1.28	2.12 ± 1.32	$.91 \pm 1.57$	2.13 ± 1.33	$2.58 \pm .77$	2.66 ± 1.06	$F = 0.83$, $p = 0.590$, $\eta^2 = 0.16$

different from: a –44 kg; b –48 kg; c –52 kg; d –56 kg; e –60 kg; f –64 kg; g –68 kg; h –72 kg; i –80 kg; j >80kg.

compared with –56, –60, –64 and –68 and –60 with –48 and –52. The heaviest weight category was different compared with all other categories in all four measured skinfolds. Moreover, only calf skinfold showed differences between –48 kg and –72 kg. The results for breadths there were significant differences between categories in the first breath, but in second, measured on the femur, differences exist between three lightest and two heaviest categories, –48 kg was also different compared with –56 kg and –60 kg. The athletes from the heaviest weight category were significantly different compared with all other athletes. In terms of arm girth and calf girth, the two lightest weight categories were different compared with the last five and that the heaviest one was different compared with all. Somatotype differences between weight categories were not found in female athletes (Table 2).

Somatotocharthe t in male categories were similar in the first four groups –52 kg, –57 kg, –62 kg, –68 kg, with typically endomorphic mesomorph type. Others athletes from heavier weight category were categorised as an extreme endomorphic mesomorphic type, while the heaviest category +100 kg differed from all other groups (Figure 1).

Female sambo athletes somatotype analysis (Figure 2) shows mostly mesomorphic endomorph body type (–44 kg, –52 kg, –60 kg, –64 kg, –72 kg).

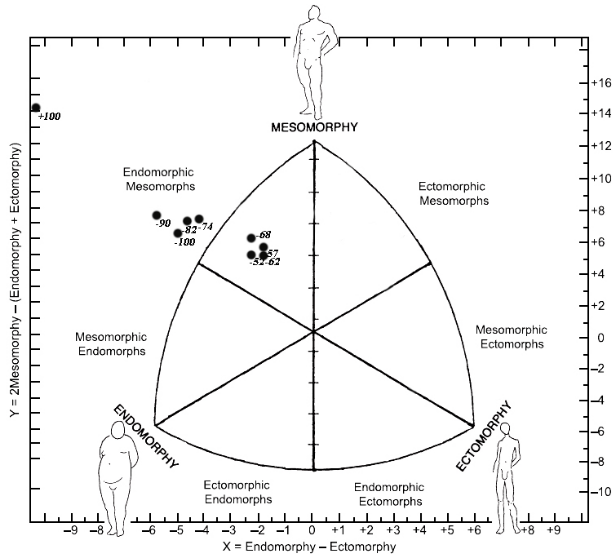

Figure 1. Somatochart of elite male sambo athletes by each weights category.

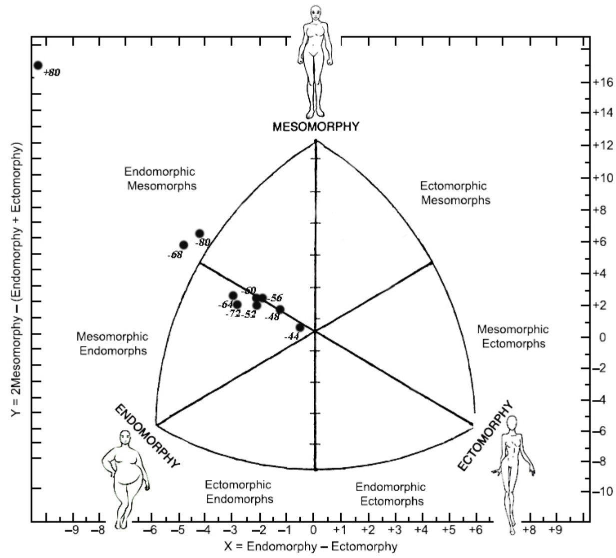

Figure 2. Somatochart of elite female sambo athletes by each weights category.

Endomorphic mesomorph type is noted in –48 kg and –56 kg. Somatotype categories were similar in the –68 kg and –80 kg with dominant endomorphic mesomorph, while the heaviest category differed from all other groups.

DISCUSSION

To our knowledge, no publications on sambo athletes have the been published in the available literature. Therefore, no concrete comparisons are possible. Our study attempts to establish the anthropometric characteristic and somatotype of elite junior male and female sambo athletes. Since sambo is weight classified sport we focused on all ten official categories. Based on obtained results male and female athletes height differed across 10 weight categories. Furthermore, with the increase in the weight, higher average height is observed in booth gender, except in heaviest weight divisions.

A linear increase of all skinfolds from first lower to the heavy category was noted, with the exception in –100 kg male category. Interesting, triceps and calf skinfolds in –100 kg where not differed in compared with all others category. Generally, the first four categories had lowered all skinfold thickness in compared with the heaviest category. Similar results have been observed on combat weight classified sports [16, 17]. All measured female skinfold thickness did not differ among category, with exception +80 kg and calf skinfold between –48 kg and –72 kg. Concerning all skinfolds, +80 kg group presented higher values compared to all other weight categories. The bigger the skinfold thickness in the segments in females compared to males observed in our study, which was also reported in judo athletes [18]. Statistical analysis of bone diameters demonstrated a linear increase from the light to the heavyweight male categories, except –100 kg. Thus, statistically significant differences in humerus breadth were only found between two lighter groups and –90 kg. Contrary, femur breadth differences were noted in all weight categories, with the biggest differences being noted in the +100 kg compared with all categories. Results for humerus breadths did not differ in a female between categories, but femur breadths were differing mainly between three lightest and two heaviest categories. Also, female athletes from the heaviest weight category were significantly different compared with all other. Concerning girths, most of the differences among male categories appeared in the arm girths with non-subsequent weigh categories, as well as concerning calf girths with a linear increase from the light to the heavyweight categories. Arm girth and calf girth in the two lightest female weight categories were different compared with the last five, while the heaviest one was different compared with all. According to authors [19], male judo athletes presented higher values than female in the humerus breadth and arm girth. Thus, our study is in accordance with a result obtained on judo athletes. This study points to distinction in anthropometric characteristics in relation to weight category in both genders. Several studies have been dedicated to determine the athletes' body composition and the dominant somatotype in different combat sports by weight division [13, 20].

Generally, in this study male sambo athletes typically showed endomorphic mesomorph somatotype, with the less expressed ectomorphic component. As shown in Figure 1 two separate homogeneous groups of weight categories were noted. First, four lightest (52 kg, –57 kg, –62 kg, –68 kg) was separate from four next heavier categories which had highest mesomorphy and endomorphy ratings, but the lowest ectomorphy rating. In addition, heaviest athletes had an extreme endomorph-mesomorph rating, but the lowest ectomorphy rating. This may result from the heavier body weight, larger skinfolds, bone breadths and girths relative to stature, compared to the other groups.

On the other hand, somatochart analysis presented in Figure 2 shows two type of somatotype. Female sambo athletes demonstrated mesomorphic endomorph (–44 kg, –52 kg, –60 kg, –64 kg, –72 kg), and other weight division shows endomorphic mesomorph component. Also, female heaviest athletes had an extreme endomorph mesomorph rating. The examined female sambo athletes show diversified anthropometric indices, body composition and somatotype by weight category. Such differences were observed in some earlier research [17, 21].

Consequently, a division of competitors into weight categories is fully justified in sambo. Literature data suggest that anthropometric studies involving somatotype show differences in athletes and that it depends on the gender and type of sports activities.

Furthermore, high-level junior male and female sambo athletes are quite similar to athletes from combat sports such as judo and wrestling [5, 22-24]. These results provide the first description of the body composition and somatotype of elite male and female junior sambo athletes. In addition, a greater diversity of somatotypes in younger athletes of both sexes compared to the elderly are noted [15]. In this matter, it is necessary to include senior sambo athletes of booth gender by weight division in the future research.

CONCLUSIONS

In summary, obtained results can serve as a basis for an anthropometrical model for elite male and female sambo athletes. A typical somatotype in male sambo athletes was endomorphic mesomorph with indicating a predominance of musculoskeletal tissue, while female athletes were classified as endomorphic mesomorph and mesomorphic endomorph in relation with weight division. This information provides reference values of anthropometric characteristics, body composition and somatotype of elite male and female junior sambo athletes. Concerning this fact, understanding the characteristics of sambo athletes will be helpful for athletes and coaches to control the training process and reduce the risk of extreme dieting. However, there is a need for future research to investigate sambo athletes in relation to age and different competitive level in an aim to generalise results.

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