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Body Composition and Somatotype of the Elite of Polish Fencers

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A B S T R A C T

The purpose of this study was to determine body composition and somatotype of the male fencers who were grouped by different fencing weapons. Analysis of body composition, with untrained men as background, will update the data necessary for the somatic profiles of fencers. Thirty contestants were examined during the Polish Fencing Championships in 2004. They took part in épée (n=10), foil (n=10) and sabre (n=10). They were aged 23.3±2.9; their length of training was 12.6±2.5 years, with the frequency of training 15.9±3.1 hours per week. In each weapon style there were champions and vice-champions of Poland from the year 2004. Twelve of them were classified among the first fifty contestants according to the D'Escrime International Federation (FIE) ranking. An experienced evaluator performed 10 measurements necessary to designate somatotypes by means of Heath-Carter method and to estimate the percentage of body fat and composition. Sabre fencers (weight=84.4 kg, somatotype=3.4–5.4–1.8) were heavier than both épée fencers (77.9 kg, 3.6–4.9–2.5) and foil fencers (74.9 kg, 2.9–4.2–2.8). Sabre specialists had higher mesomorphy than foil fencers (ANOVA and Bonferroni's multi comparison test). Sabre fencers were characterized by higher fat free mass and a higher BMI and fat free mass index than fencers of the other two weapons. Discriminant analysis result was significant ($p<0.01$) with a relative percentage with a 72.4 and a canonical correlation coefficient 0.692, and Wilks' $\lambda=0.385$. Amongst the 30 observations used to fit the model, 22 (73.3%) were correctly classified. Against the background of non-training men, fencers were distinguished by a higher body weight (79.0 vs. 72.1 kg, $t=3.97$, $p<0.001$) and a higher height-weight ratio (43.21 vs. 42.46, $t=2.24$, $p<0.05$). Fencers' somatotypes differed from the somatotypes of the untrained (3.3–4.8–2.3 vs. 3.7–4.3–3.1). They were characterized by their higher mesomorphy ($t=2.10$, $p<0.05$) and lower ectomorphy ($t=3.48$, $p<0.01$), as well as greater adiposity (16.8 vs. 15.7%, $t=2.03$, $p<0.05$).

Key words: *fencers, body composition, somatotype*

Introduction

Different sports disciplines establish certain requirements to sportsmen who, wishing to succeed, target their training according to tournament requirements. The relation between structure and function is often considered with regard to somatotype[1,2]. Determinants of players' functional and morphological predispositions in combat sports, in which there is a division into categories of weight, have been described, among others, in judo[3] and karate[4].

In judo, throws are preferred, whereas, in ground phase – pinning techniques, joint and strangling techniques are used. Selection of techniques and fight indices are linked to both weight category and the level of achievement in a judo tournament[6]. Karate belongs to a group of combat sports in which hand and foot strikes are allowed. The proportions of their use and effectiveness depend on morphological characteristics of players[4]. In fencing, there is no division into weight categories. As Rodriguez[7] stated: »Fencing is a safe armed combat sport. There are three weapons, 3 sets of rules, 3 different tactics: 1. Épée: tip hit, whole body is valid. 2. Foil: tip hit, valid only on torso. 3. Sabre: tip, edge and counter edge, valid only from the waist up. Bouts of 3 periods, each of 3 minutes of combat time and 1 minute rest or 15 hits scored. »Sudden Death« pattern and at most 5 bouts for the medal finalists set the scene for a very short, but very intense competition«[7]. Few pieces of information on somatotype of fencers come from early publications[1], while

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the latest do not take into account a division of players according to weapons used in combat[8]. The literature review shows that little is known about characteristics of body build of Polish fencers, what could enrich our knowledge of the subject.

The purpose of this study is to determine body composition and somatotype of the male fencers who were grouped according to different fencing weapons. Analysis of body composition, with non-training men as background, will update the data necessary for the somatic profiles of fencers.

Material and Methods

Subjects studied

30 players were examined during the Polish Men's Fencing Championships (Krakow, 1–6.06.2004). National team coaches selected 10 representatives in each weapon: épée (e), foil (f), sabre (s), who then agreed to take part in research. An interview was done to obtain data on age, training period (in years) and training volume (hours per week). The sports level was established on the basis of results obtained in the 2004 Championships of Poland.

Tables 1 and 2 present the characteristics of the examined men. The average values of age ($F=0.06$) and training period ($F=0.44$) of the subjects in the three fencing events do not differ significantly ($p>0.05$). Duration of training (hours per week) in the three groups of fencers was also similar ($F=2.00$, $p>0.05$). Data of 165 randomly selected untrained men, students of the Warsaw University of Technology[9], were used to compare fencers' body build and body composition. In total fencers were older and more diverse in terms of age than untrained students.

On the basis of fencers' sports performances two groups were created. Group A (n=12) consisted of those who won medals in the Polish Fencing Championships in 2004, or were classified among the first fifty FIE contestants in the seasons 2003/2004 and 2004/2005 according to an official D'Escrime International Federation (FIE) individual ranking[10]. Group B (n=18) consisted of players who did not win any medal in the Polish Championships in 2004 and took downstream positions (n=15) according to FIE ranking or were not listed there in the years 2003/2004–2004/2005 (n=3). In each weapon (e, f, s) four players from group A and six from group B were selected. Thus, group A had 12, while group B – 18 fencers.

Anthropometry

Body adiposity was measured by means of a Holtain caliper with a contact surface pressure of 10 g/mm^2. To determine somatotype 10 required measurements were used: body height and mass, four skinfold measurement (triceps, subscapular, supraspinale and medial calf), two girths (arm flexed and tensed, and calf), bi-epicondylar breadths of humerus and femur[1]. In addition – for the comparison with a group of untrained students[9] – a thickness of abdominal skinfold was measured[11]. A qualified employee of the Department of Anthropology, with a 35-year experience conducted anthropometric measurements, using the SiberHegner Machines SA (Zurich, Switzerland) instruments. To calculate the body density an equation[11]:

$$D = 1.125180 - 0.000176 \mathrm{LOG}\,\mathrm{triceps} - 0.000185 \mathrm{LOG}\,\mathrm{abdominal}$$

was used, with a logarithmic value = 100*log10 (compass measurement expressed in tenths of mm minus 18, as the correction for the thickness of the skin). To transform skinfolds measurements the Edwards et al. table was used[12]. The fat percentage in body mass was calculated on the basis of the following equation[13]:

$$\%\mathrm{PF} = 100\left(\frac{4.201}{D} - 3.813\right)$$

A Tanita scale (model: TBF 300, Tanita Co., Tokyo, Japan) was used for measuring body mass (Wt). Then height-weight ratio HWR (height/mass$^{-0.33}$), body mass index BMI (wt in kg/ height in m^2), fat mass FM and fat free mass FFM (Wt-FM) were calculated. Similarly to BMI, fat free mass index (FFMI) and fat mass index (FMI) were calculated[14].

Statistical analysis

Average values ($\bar{X}$) and standard deviation (SD) of age, training experience, training volume (hours per

TABLE 1
AGE, TRAINING PERIOD, HOURS PER WEEK, HEIGHT, MASS AND HWR AND SOMATOTYPE OF MEN WHO PARTICIPATED IN THE POLISH CHAMPIONSHIPS IN 2004 BY FENCING EVENTS ($\bar{X}$±SD)

Group	Age (years)	Training period (years)	Hours per week	Height (cm)	Weight (kg)	HWR	Endo morphy	Meso morphy	Ecto morphy
Épée (n=10)	23.7±2.10	13.1±2.41	17.2±2.24	180.9±7.40	77.9±6.67	43.19±2.42	3.6±1.40	4.9±0.99	2.5±1.08
Foil (n=10)	23.2±2.42	12.0±1.41	16.0±2.43	180.1±4.36	74.9±6.03	42.81±1.05	2.9±0.97	4.2±0.86	2.8±0.76
Sabre (n=10)	22.9±4.04	12.6±3.34	14.5±4.00	181.3±4.23	84.4±6.64	41.37±1.26	3.4±0.80	5.4±0.65	1.8±0.83
Total (n=30)	23.3±2.89	12.6±2.46	15.9±3.11	180.8±5.35	79.0±7.42	42.46±1.81	3.3±1.09	4.8±0.97	2.3±0.96
Untrained (n=165)	20.6±0.97			179.4±6.19	72.1±8.96	43.21±1.66	3.7±1.48	4.3±1.23	3.1±1.19

TABLE 2
BMI, FFM, FFMI, FM, FMI, BODY DENSITY D AND PERCENT FAT %PF IN BODY MASS OF MEN WHO PARTICIPATED IN POLISH CHAMPIONSHIPS 2004 BY FENCING WEAPONS
($\bar{X}$±SD)

Group	BMI (kg/m^2)	FFM (kg)	FFMI (kg/m^2)	FM (kg)	FMI (kg/m^2)	D g/M^3	%PF
Épée (n=10)	23.8±1.88	64.5±4.45	19.7±1.08	13.4±3.32	4.1±1.03	1.0545±0.008	17.1±3.08
Foil (n=10)	23.0±1.62	62.7±4.57	19.3±1.13	12.1±2.58	3.7±0.82	1.0571±0.007	16.1±2.79
Sabre (n=10)	25.7±1.98	69.8±4.48	21.3±1.61	14.5±2.93	4.4±0.80	1.0545±0.006	17.1±2.39
Total (n=30)	24.2±2.10	65.7±5.32	20.1±1.52	13.4±3.03	4.1±0.90	1.0554±0.007	16.8±2.72
Untrained (n=165)	22.4±2.46	60.6±6.28	19.5±2.02	11.5±3.20	3.7±1.03	1.0580±0.007	15.7±2.74

BMI – body mass index, FFM – fat free mass, FFMI – fat free mass index, FM – fat mass, fat mass index, D – density, %PF – pecent fat in body mass

week), height and weight, somatotype and BMI, FFMI, FMI, and %PF indices were calculated. A special computer software »Somatotype calculations and analysis« was used to work out the results pertaining to the classification of somatotype defined by means of Heath-Carter method[15].

The group average for épées, foils and sabres were compared by means of the ANOVA method, and in case of significant differences a Bonferroni's multiple range test was used. Somatotype distributions of fencers by fencing groups were shown. Individual results in groups of fencers were illustrated on a body composition chart (BC), as a single graph allows the presentation of the BMI, FFMI, FMI, and %PF[14]. Discriminant analysis was used to build a predictive model of group membership with fencing event as a grouping factor. In addition, the ANOVA method was used, taking groups A and B into account. Also, Spearman's rank correlation coefficient (σ) was calculated between the place occupied in the Polish Championship in 2004 and variables characteristics for the contestants. Somatotype of fencers, measurements and indices of weight and body composition were compared with a group of untrained men[9]. To assess the differences between the two averages a t-test for independent groups was performed. The statistics of the results was done in the computer software STATGRAPHICS Centurion XV.

Results

Descriptive statistics of groups of fencers according to fencing events (and in total) and untrained men are presented in Tables 1 and 2.

Comparison by fencing events

The analysis showed that there were statistically significant differences between the three groups of fencers. They concerned body weight ($F=5.66$, $p<0.01$), mesomorphy ($F=5.50$, $p<0.01$), the FFM value ($F=6.73$, $p<0.01$), the BMI indices ($F=5.54$, $p<0.05$) and the FFMI ($F=6.42$, $p<0.01$). Statistically significant differences between pairs of means were identified using a Bonferroni's multiple range test. Sabre fencers were heavier than épée and foil fencers. Sabre fencers had significantly higher mesomorphy, the FFM, and levels of the BMI and the FFMI than foil fencers themselves. In addition, higher values of FFM and FFMI were characteristic for sabre fencers rather than épée fencers. Individual somatotypes and group means of men who practise different fencing styles are shown in figure 1, while the values of BMI, FFMI, FMI, and %PF are presented on the body composition chart (Figure 2).

The level of mesomorphy is the highest in the group of sabre fencers, average in the group of épée fencers and the lowest in the group of foil fencers.

Endomorphic mesomorph is a characteristic somatotype for sabre fencers and, therefore, it is dominant in this group (7/10). Two out of ten of sabre fencers are characterized by a balanced mesomorph and one out of ten by an ectomorphic mesomorph.

Foil fencers represent a balanced mesomorph somatotype (mesomorphy is dominant, endomorphy and ectomorphy are smaller or equal (or not differ by more than

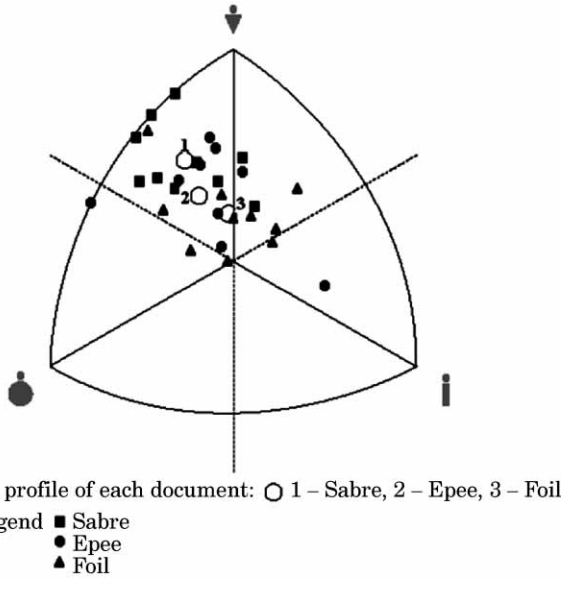

Fig. 1. Somatotype distribution by fencer events (O – mean of each group).

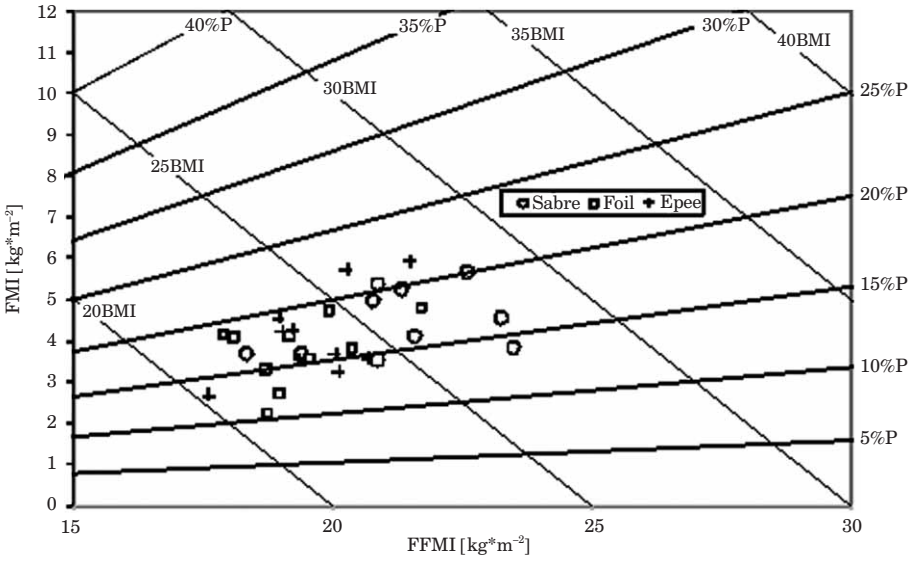

Fig. 2. Body composition chart for fencers by event. FFMI – fat free mass index, FMI – fat mass index. Oblique lines represent BMI – body mass index and %PF – fat percentage in body mass.

one-half unit). Such mean value consists of individual somatotypes classified in four different somatotypes: mesomorph-endomorph (n=2), balanced mesomorph (n=2), ectomorphic mesomorph (n=2), mesomorph ectomorph (n=2), endomorphic mesomorph (n=1) and the central type (n=1). Endomorphic mesomorph is typical for épée fencers as well as for sabre fencers. In the first group there is a higher frequency of endomorphic mesomorph occurrence (4/10). Mesomorphic endomorph, balanced mesomorph (two fencers in each), mesomorph endomorph and the central type (one fencer in each) also occur.

On the body composition chart (Figure 2) the characteristic features of fencers are mainly marked on the surface designated between lines BMI 20 and 30 kg/m^2 (from 20.2 to 28.2 kg/m^2), with the percentage of fat between 10.7 and 21.8%.

Although 7 sabre, 2 épée and 1 foil fencers have a BMI value indicating overweight (BMI>25 kg/m^2), the percentage of fat, can not be unequivocally accepted as such an assessment because these subjects have a high FFMI. Among all fencers who used a variety of arms: épées, foils and sabers, the range of variation of FFMI and FMI ranged respectively from 17.6 to 23.5 kg/m^2, and from 2.2 to 5.9 kg/m^2.

Discriminant analysis

The discriminant function analysis used the weight and the three somatotype components, endomorphy, mesomorphy and ectomorphy by fencing groups. Function 1 is significant ($p<0.01$) with a relative percentage 72.4 and a canonical correlation coefficient 0.692, and Wilks' $\lambda=0.385$. The coefficient of the function used to discriminate amongst the different fencing groups is:

D1=0.925673*mass in kg–0.150851*Endomorphy+ 1.27159*Mesomorphy+0.865677*Ectomorphy.

This function group centroid discriminates between sabre and foil. It separates them by 2.23 units. Three observations in épée group are incorrectly classified into foil (n=2) and sabre (n=1) groups. Two observations in sabre group were incorrectly classified into épée group. Amongst the 30 observations used to fit the model, 22 (73.3%) were correctly classified.

A comparison according to level of achievements

When comparing groups according to the sports level it was found that group A contestants were older than the contestants of group B (24.7±3.52 vs. 22.3±1.99 years, t=2.30, $p<0.05$), had a longer period of training (13.3±3.20 vs. 12.0±1.73, t=1.45, $p>0.05$) and trained

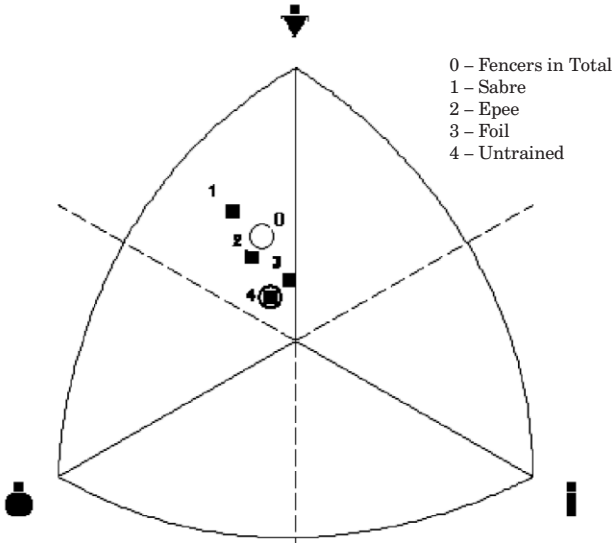

Fig. 3. Mean somatotypes of fencers and untrained males.

more frequently (17.0±2.16 vs. 15.1±3.45 hours per week, t=1.70, p>0.05), what suggests their greater experience. Age and training period were significantly correlated (σ=0.66, p<0.001). The contestants occupied certain places in the ranking after the Polish Championships in 2004. For the whole group of fencers, their rank depended on their body height (σ=–0.37, p<0.05). In foil, a place in the ranking highly correlated with the fencer's height (σ=–0.77, p<0.05), while in sabre it depended on the number of weekly training hours (σ=–0.80, p<0.05). In épée group, no statistically significant correlations were found.

Comparison of fencers to untrained men

Fencers (in total) were more diverse in age and older by 2.7 years than untrained adult men. They did not differ in body height (t=1.161). Fencers were significantly heavier (t=3.97, p<0,001), and were characterized by a more massive body build, as shown by the indices of HWR and BMI (t=2.24, p<0.05 and t=3.76, p<0.001). On Figure 3 the location of the fencers' mean somatotype (0) towards untrained students of the Warsaw University of Technology (4) was illustrated.

Both compared somatotypes (no. 0 and 4) are classified as endomorphic mesomorph (mesomorphy is dominant and endomorphy is greater than ectomorphy), but the fencers had more mesomorphy (t=2.10, p<0.05) and less ectomorphy (t=3.48, p<0.001). There were no significant differences in endomorphy. Compared to untrained men (table 2), the fencers had greater fat free mass (t=4.18, p<0,001), and fat mass (t=3.01, p<0.01). FFMI was higher than in untrained men, but the difference between the means was not statistically significant (t=1.55). The FMI and the percentage of fat were higher for fencers than for the untrained men (t=2.03, p<0.05).

Discussion

Fencing weapons

In the undertaken research, there were no statistically significant differences in age between fencers practising different weapons. A similar phenomenon was observed for the 2006 World Championships[16].

Table 3 presents characteristics of men's somatotype, with regard to different fencing weapons.

In the present research it was shown that fencers of particular weapons have different anthropological characteristics. Polish sabre fencers were heavier than foil fencers. They had higher mesomorphy, more FFM and higher levels of BMI and FFMI. Sabre fencers were also heavier than épée fencers, had more FFM and higher FFMI.

In Spain, there were significant differences among representatives of the three weapons. Épée fencers were taller than foil and sabre fencers who had the lowest ectomorphy[19]. Among the Spanish fencers the highest mesomorphy was characteristic for sabre representatives, which is consistent with the research results concerning Polish players. These observations update the earlier views. Cuban sabre fencers indeed had the lowest mesomorphy[17], or the same as in practising with the other weapons[18]. Authors of the well-known monograph[1] concludes that »The somatotype variations of the Olympic athletes, Czechoslovak, Hungarian and Bolivar Games fencers are seen across the full width of the endo--mesomorph and ecto-mesomorph categories. The Cuban fencers are more ecto-mesomorphic and the Hungarians are more endo-mesomorphic than the Olympians. Except for slightly higher ectomorphy for sabre fencers in these two samples, there is little difference among events«.

Level of achievement

In the present study a sports level was connected to fencers' experience (age), as evidenced by a comparison of groups A and B. It is interesting that the age of the participants of the 2006 World Championships[16] was higher (25.6 years) than the age of group A (24.7 years).

In men's foil a strong correlation of the ranking in the Polish Championships with a body height was observed. In the sabre fencers rank it correlated with a training volume (hours per week). Those who practised more hours per week achieved a higher ranking position. In Poland macro region team of junior players were 6 years younger (n=50; 16.85 years) than the Olympic contes-

TABLE 3
AGE, HEIGHT, WEIGHT AND SOMATOTYPE OF MALE GROUPED BY FENCING WEAPONS (MEAN±SD)

Country	Fencers weapon (n)	Age (years)	Height (cm)	Weight (kg)	Somatotype
	Épée (8)	23.0±2.0	175.4±4.5	71.8±2.8	2.1–5.4–2.4±0.4–0.8–0.3
Cuba[17]	Foil (8)	22.8±2.1	172.2±6.4	66.0±7.2	2.4–4.9–2.6±0.4–0.9–0.7
	Sabre (5)	24.2±1.5	178.3±5.2	71.6±5.8	2.2–4.6–2.8±0.6–0.8–0.7
	Épée (33)	25.5±6.5	177.4±5.3	73.5±7.3	2.8–5.2–2.0±0.8–0.7–1.0
Hungary[1,18]	Foil (34)	24.9±6.1	173.4±4.6	173.4±4.6	2.8–5.2–1.8±1.0–0.8–0.8
	Sabre (24)	23.8±6.0	178.4±5.7	178.4±5.7	2.5–5.2–2.3±0.7–0.7–0.8
	Épée (7)	27.4±3.1	184.4±6.8	75.9±4.4	1.9–4.0–3.6±0.4–0.9–1.0
Spain[19]	Foil (5)	24.0±3.6	176.0±2.0	69.1±4.4	2.2–4.7–2.9±0.5–0.8–0.5
	Sabre (5)	24.5±2.3	174.1±4.5	73.1±8.8	3.0–4.8–2.0±0.9–0.4–0.6

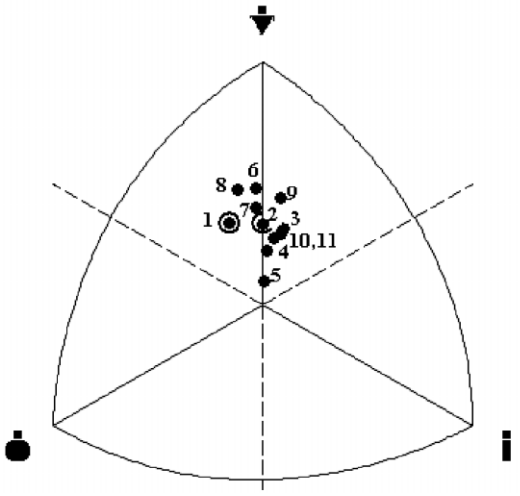

Fig. 4. Somatotype of Polish national team fencers (POL) compared to other studies: 1-POL → endomorphic mesomorph; 2-ARG 2006 → balanced mesomorph; 3-ESP 1997 → ectomorphic mesomorph; 4-ESP 1993 → balanced mesomorph; 5-TUR 1986 → central; 6-ITA 1983 → balanced mesomorph; 7-BOL 1981 → endomorphic mesomorph; 8-HUN 1980 → endomorphic mesomorph; 9-CUB 1976-80 → balanced mesomorph; 10 – Montreal 1976 → balanced mesomorph; 11-CSR 1971 → balanced mesomorph; 0 – mean somatotype of fencers estimated on the basis of all data collected 2.65-4.66-2.65.

tants (n=28, 23.28 years). They had lower weight (66.96 vs. 76.61 kg) and body height (171.7 vs. 181.8 cm). In the combined group of juniors and seniors (n=78) body height negatively (r=–0.62) influenced the fencers' sports level. It was found also that body height shorter than 170 cm may be a substantial obstacle in the implementation of technical-tactical elements, whereas, body composition did not affect the achievements in sporting activities[20].

In the current study, there were no significant differences between somatotype and body composition and the level of performance in the Polish Championships and the FIE ranking. The findings on the importance of body build in fencing are not as clear as in the combat sports where the players are divided into weight categories. The research performed on karate players found the relation between morphological characteristics and the effectiveness of the hand and foot techniques, and their combination in the fight, as well as the relation between sports achievements and a morphological factor[4].

Somatotype in time perspective

On Figure 4 the mean somatotype of fencers is illustrated, on the basis of original research (1-POL) against the results of studies (no. 2-11) published by other authors (Zrubak and Hrcka 1976[21], Carter et al 1982[22], Rodriquez et al 1989[17], Eiben 1980[18] (as in Carter Heath 1990[1]), Brief 1986[23], Ergen 1985[24], Yazici 1986[25], Esparza Ros 1993[26], Iglesias I Reig 1997[19], Lentini et al. 2006[8]). For comparative purposes the names of somatotypes are used after the »Category Chart Key« presented in a special computer program – »Somatotype calculations and analysis«[15].

Of the eleven trials (comparative series), balanced mesomorph appeared in seven, endomorphic mesomorph

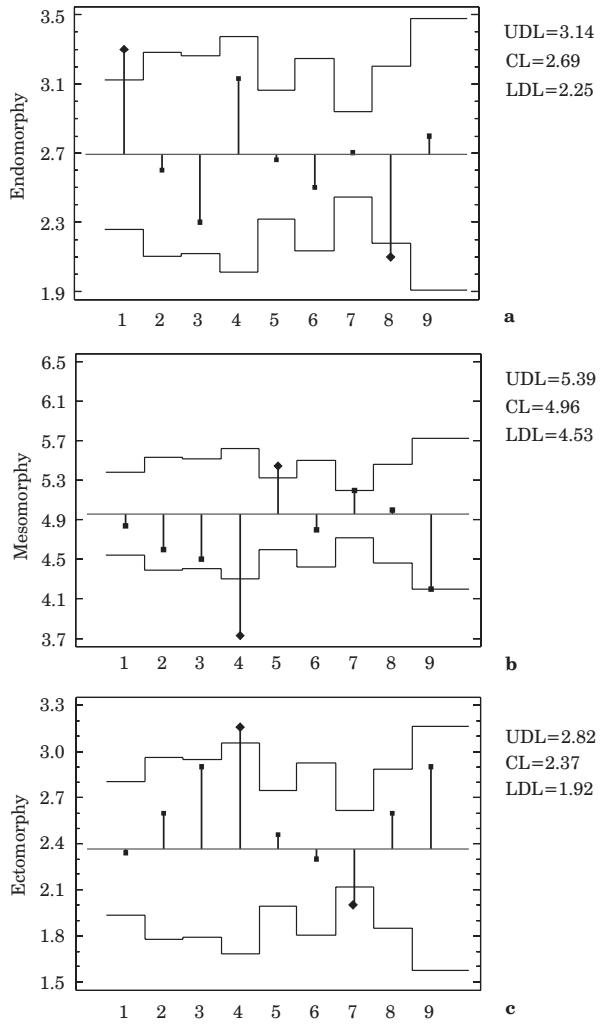

Fig. 5. a) Mean analysis (ANOM) of endomorphy component of fencers' somatotypes: 1-POL; 2-ARG Lentini 2006; 3-ESP Iglesias 1997, 4-TUR Yazici 1986; 5-ITA Ergen 1985; 6-BOL 1981, Brief 1986; 7-HUN Eiben 1980 (after Carter i Heath 1990); 8-CUB 1976-80, Rodriguez et al. 1985; 9-Olympic Games Montreal, 1976, Carter et al. 1982. Abbreviations: UDL-upper decision limit, CL-central line, LDL-lower decision limit. b) Mean analysis (ANOM) of mesomorphy component of fencers' somatotypes: 1-POL; 2-ARG Lentini 2006; 3-ESP Iglesias 1997, 4-TUR Yazici 1986; 5-ITA Ergen 1985; 6-BOL 1981, Brief 1986; 7-HUN Eiben 1980 (after Carter i Heath 1990); 8-CUB 1976-80, Rodriguez et al. 1985; 9-Olympic Games Montreal,1976, Carter et al. 1982. Abbreviations: UDL-upper decision limit, CL-central line, LDL-lower decision limit. c) Mean analysis (ANOM) of ectomorphy component of fencers' somatotypes: 1-POL; 2-ARG Lentini 2006; 3-ESP Iglesias 1997, 4-TUR Yazici 1986; 5-ITA Ergen 1985; 6-BOL 1981, Brief 1986; 7-HUN Eiben 1980 (after Carter i Heath 1990); 8-CUB 1976-80, Rodriguez et al. 1985; 9-Olympic Games Montreal,1976, Carter et al. 1982. Abbreviations: UDL-upper deision limit, CL-central line, LDL-lower decision limit.

in two, ectomorphic mesomorph in one, and a central type in one. Somatotype of Argentinian national team (no.2) coincides with the mean of the whole. Somatotype of attitudinal distance SAD ranges from 0.09 to 1.16, reaching on average 0.59. The results of studies were arranged in a chronological order. Based on the chart of mean ANOM analysis (Figure 5a), it can be concluded that the value of endomorphic component of Polish players (1) is significantly higher than the grand mean of 9 groups. SD values were not available in the ESP 1993 group[26] and the 1971 CSR group[21]. The average value of endomorphy for Cuban players (no. 8) is significantly lower than the grand mean (under lower decision limit LDL).

The results of Polish fencers (POL) are average against the grand mean of mesomorphy from all the data presented in the ANOM chart (Figure 5b). Significantly higher mesomorphy than the grand mean (higher than upper decision limit UDL) is characteristic for Italian fencers (no. 5), and lower for Turkish fencers (no. 4).

Among the compared groups, the value of ectomorphy of Poles is average (Figure 5c), while in a group of Turkish fencers (no. 4) it exceeds the UDL. The Hungarian group (no. 7) is characterized by significantly lower ectomorphy than the grand mean (CL).

Fencers vs. untrained men

Fencers were indeed heavier and were characterized by a more massive body build than the compared group. Although somatotypes of training and untrained men were classified as endomorphic mesomorph (mesomorphy is dominant and endomorphy is greater than ectomorphy), the fencers had higher mesomorphy and lower ectomorphy. Fencers also had higher fat free mass and fat mass. Their fat mass index and fat percentage did not depend on used fencing weapons, and was higher than for untrained men. The difference of adiposity of leading Polish fencers (16.8%) and untrained men (15.7%) is significant statistically, but group means are within the normal range of fat percent in men's body mass. It should not be lower than 4 and higher than 25%PF[27]. Karate players, with respect to a comparative group, (Croatian Army recruits) were characterised by marked muscular mass (mesomorphy) with increased transverse skeleton dimensionality and minimal adipose tissue[4].

In the light of the collected results, further complex study is needed to clarify the sports outcome of fencers, taking into account such factors as the level of targeted physical preparation, technical preparation, tactical preparation, mental preparation etc.

Conclusions

Somatotypes of representatives of the three fencing weapons differ statistically significantly. Polish sabre fencers were heavier than foil fencers, had higher mesomorphy, more FFM and higher levels of BMI and FFMI. Sabre fencers were also heavier than épée fencers and had more FFM and higher FFMI. Mesomorphy increases from foil, through épée, to sabre, however in the case of ectomorphy the system is reverse.

Age, body height and training volume are linked to players' achievements in fencing weapons in various ways. No relation was observed between somatotype and ranking in competitions.

Among all examined fencers different somatotypes appear. The most common are endomorphic mesomorph and balanced mesomorph. Fencers – against the background of untrained men – are heavier, more ectomorphic and have higher mesomorhy. They are heavier and more massive than the comparative group. Fat mass index and fat percentage did not depend on fencing weapons, and were higher than in untrained men.

4. Body build of Polish fencers (this study), compared to data from the world's literature, is characterized by the increased value of endomorphic component.

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TJELESNI SASTAV I SOMATOTIP ELITNIH POLJSKIH MAČEVALACA

S A Ž E T A K

Cilj je ove studije odrediti tjelesni sastav i somatoptip muških mačevalaca. Analiza tjelesnog sastava dopunit će podatke o somatskim profilima mačevalaca. Ispitano je trideset natjecatelja za vrijeme Poljskog mačevalačkog natjecanja u 2004. koji su se natjecali su se natjecali u sljedećim stilovima: épée (n=10), foil (n=10) i sabre (n=10). Prosječna dob ispitanika bila je 23,3±2,9 godina, duljina treniranja 12,6±2,5 godina, a učestalost treniranja bila 15,9±3,1 sati tjedno. U svakom mačevalačkom stilu bilo je šampiona i vicešampiona Poljske u 2004. Dvanaest od njih je klasificirano među pedeset prvih natjecatelja prema rangiranju D'Escrime International Federation (FIE). Procjenitelj s iskustvom obavio je 10 mjerenja potrebnih da bi se odredio somatotip prema Heath-Carterovoj metodi i da procjeni postotak tjelesne masti i tjelesnog sastava. Sabre mačevaoci (težina=84,4kg, somatotip=3,4–5,4–1,8) bili su teži od épée mačevalaca (77,9 kg, 3,6–4,9–2,5) i foil mačevalaca (74,9 kg, 2,9–4,2–2,8). Sabre mačevaoci imali su veću mezomorfiju od foil mačevalaca (ANOVA and Bonferronijev test). Sabre mačevaoce karakterizira veći postotak mase bez masti i veći indeks tjelesne mase te indeks mase bez masti od mačevalaca iz druge dvije kategorije. Rezultat diskriminantne analize bio je značajan ($p<0,01$) s relativnim postotkom od 72,4 i korelacijskim koeficijentom od 0,692, i Wilksovoj $\lambda=0,385$. Među 30 promatranja koja su ušla u model, 22 (73,3%) su bila točno klasificirana. U usporedbi sa kontrolom koju su činili muškarci koji ne treniraju, mačevaoci su se razlikovali većom tjelesnom težinom (79,0 vs. 7,42 kg, $t=3,97$, $p<0,001$) i većim omjerom težina-visina (42,46 vs. 43,21, $t=2,24$, $p<0,05$). Somatotipovi mačevalaca razlikovali su se od somatotipova kontrole (3,3–4,8–2,3 vs. 3,7–4,3–3,1) koju je karakterizirala veća mezomorfija ($t=2,10$, $p<0,05$) i manja ektomorfija ($t=3,48$, $p<0,01$), kao i veća adipoznost (16,8 vs. 15,7%, $t=2,03$, $p<0,05$).