

Original Article

Peculiarities of the somatotype of athletes with different directions of the training process

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Abstract:

The reaction of the athletes' organism on the physical loads is mostly determined by the peculiarities of their somatotype and plays an important role in the selection of sport activities. Therefore we have used the Heath-Carter somatotyping to describe the peculiarities of somatotypes of the athletes, representing 12 different sports (188 males with sport experience more than 5 years). The aim of the study was to compare the somatotypes of athletes with different directions of training process. It was found the two dominant somatotypes for combat sports athletes: balanced mesomorph (average somatotype for gopak fight is 2.39–4.44–2.71; for fencing – 2.53–5.28–2.18) and endomorphic mesomorph (karate WKF – 3.67–5.27–2.85; boxing – 3.66–4.58–2.81). The mesomorphy dominates in somatotype of the athletes, who participate in strength sports, wrestling, rowing and swimming. The most frequently observed somatotype in the groups of weightlifters (2.89–5.68–2.26), wrestlers (5.11–5.70–1.84), rowers (4.48–5.38–2.23) and swimmers (3.65–4.52–2.76) was endomorphic mesomorph. In the group of athletes, who participate in game sports, the somatotypes of balanced mesomorph (volleyball – 3.09–4.54–3.08 and tennis – 3.60–4.62–3.27) or endomorphic mesomorph (football – 3.75–4.34–3.16) prevail. The average somatotype of high jumpers is 2.73–2.73–4.89 (balanced ectomorph). We can suppose the increase of ectomorphy in the case of high amount of vertical jumping elements during competitive and training activity (games, high jumping). The mesomorphy becomes dominant when the speed and strength loadings prevail (combat sports, weightlifting, wrestling, rowing and swimming). In this case the highest endomorphy has been found among the athletes, engaged in the sports without essential amount of vertical body movements (wrestling, rowing and swimming).

Key words: somatotype, Heath-Carter, gopak fight, fencing, karate, boxing, weightlifting, wrestling, rowing, swimming, volleyball, tennis, football, high jumping.

Introduction

The training of highly skilled athletes requires deep analysis and consideration of their anatomical and physiological characteristics. The adaptation of training process to the peculiarities of the physique and composition of the body of athlete and to some other morphological and functional characteristics creates the conditions for complete realization of his physical abilities (Vovkanych, Kutseryb, Hrynkiv, & Muzyka, 2015). There are only a few studies in which the body structure of athletes has been evaluated with the use of the modern approaches of constitutional morphology, the model somatotypes of the athletes of different sports are compared and individual differences have been revealed (Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2015; Koropanovski et al., 2011; Kutseryb et al., 2016; Martirosov, 1982; Martirosov, 1998). Several authors have examined the morphological peculiarities of wrestlers (Hrynkiv et al., 2013; Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2015, Tanner, 1964) and boxers (Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2015; Vovkanych, Kutseryb, Hrynkiv, & Muzyka, 2015). Some authors (Hrynkiv et al., 2013; Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2014; Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2015; Kutseryb et al., 2016; Martirosov, 1982; Vovkanych, Kutseryb, Hrynkiv, & Muzyka, 2015) have examined the morphological peculiarities of the athletes of combat sports. There are very few studies described the distinctive characteristics of body structure, proportions and somatotype of the weightlifters, wrestlers and athletes of other sports (Hrynkiv et al., 2013; Koropanovski et al., 2011; Krawczyk, Sklad, & Jackiewicz, 1997; Kutseryb, Hrynkiv, Vovkanych, & Muzyka, 2015; Martirosov, 1998; Štepička, 1972).

However, the usage of different (often outdated) constitutional schemes in various observations significantly complicates the somatotype determination and makes it impossible to compare their results (Carter, Heath, 1990, Ramirez-Velez et al, 2014; Krawczyk, Sklad, & Jackiewicz, 1997). Therefore, the necessity of comprehensive analysis of the somatotypes of skilled athletes with the use of modern, most commonly used methods arises. The main **purpose** of the present study was to compare the somatotypes of athletes with different direction of training process.

Material & methods

The subjects were 188 males athletes aged 17–24 years, who represent 12 different sports, with sport experience more than 5 years (detailed description is provided in Table 1). All the participants were informed about the aim and methodology of the study and they volunteered to participate in this study. Informed consent was obtained. This study was approved by ethics committee of the Lviv State University of Physical Culture. All procedures accorded with the principles of the Code of Ethics of the World Medical Association (Declaration of Helsinki). Somatotype was determined using the categorizations, proposed by Heath–Carter (Carter, 2002). It is recommended for people of both sexes aged 14 to 70 years, including the athletes. Somatotypes were estimated using the Heath-Carter anthropometric method by means of equations (Carter, 2002). In order to determine somatotypes, the body mass (measured with Tanita BC 601), body height (measured with anthropometer), skinfolds (Skinfold Caliper Baseline 12–1130), girths and breadths were measured (Carter, 2002, Koropanovski et al., 2011; Sterkowicz-Przybycień, Sterkowicz, & Żarów, 2011). All measurements were taken from the right side of the body by the same tester. The statistical analysis was carried out by SPSS 11.5 package software. All values are given as mean $\pm$ SEM (standard error of the mean).

Table 1. The description of the groups of athletes (mean $\pm$ SEM)

Sport category	Sport	n	Age, years	Height, cm	Weight, kg
Combat sports	Gopak fight	16	18 – 24	178.14 $\pm$ 2.87	69.75 $\pm$ 2.86
	Karate WKF	12	17 – 19	179.00 $\pm$ 1.40	76.01 $\pm$ 2.18
	Fencing	16	17 – 19	170.92 $\pm$ 8.02	67.59 $\pm$ 6.58
	Boxing	16	18 – 20	174.47 $\pm$ 7.83	67.55 $\pm$ 8.26
	Wrestling	16	19 – 21	175.31 $\pm$ 10.93	75.65 $\pm$ 12.38
Athletics	High jumping	16	19 – 24	192.88 $\pm$ 2.98	75.19 $\pm$ 3.22
Strength sports	Weightlifting	16	18 – 21	172.86 $\pm$ 5.60	69.61 $\pm$ 8.13
Aquatic & paddle sports	Rowing	16	18 – 21	174.19 $\pm$ 6.19	71.46 $\pm$ 8.02
	Swimming	16	18 – 21	177.25 $\pm$ 6.25	71.41 $\pm$ 7.20
Games	Volleyball	16	18 – 21	180.59 $\pm$ 10.28	73.14 $\pm$ 9.36
	Tennis	16	18 – 21	177.89 $\pm$ 6.84	69.09 $\pm$ 11.19
	Football	16	18 – 21	177.88 $\pm$ 6.99	69.86 $\pm$ 10.22

Results

For athletes of combat sports (gopak fight, karate WKF, fencing and boxing) the most dominant component of somatotype was mesomorphy, probably as the result of high musculoskeletal robustness. The somatotype of gopak fighters and fencers was balanced mesomorph. The average somatotype of the gopak fighters was 2.39–4.44–2.71 and fencers – 2.53–5.28–2.18 (Table 2). The lowest level of mesomorphy among the athletes of combat sports was revealed for gopak fighters (4.44 $\pm$ 0.38). These results clearly suggest the higher muscular development of the athletes, engaged in fencing, karate and boxing. The fencers were characterized by lowest values of ectomorphy (2.18 $\pm$ 0.99), which describes the relative linearity or slenderness of a physique. Gopak fighters and karate athletes featured the lowest endomorphy levels (2.39 $\pm$ 0.57 and 2.53 $\pm$ 0.77). It means the smallest body fat mass.

Table 2. The average levels of Heath-Carter somatotype components of different sports athletes

Sport	Component (mean $\pm$ SEM)			Somatotype categories
	Endomorphy	Mesomorphy	Ectomorphy	
Gopak fight	2.39 $\pm$ 0.57	4.44 $\pm$ 0.38	2.71 $\pm$ 0.63	Balanced mesomorph
Karate WKF	3.67 $\pm$ 0.67	5.27 $\pm$ 1.05	2.85 $\pm$ 0.57	Endomorphic mesomorph
Fencing	2.53 $\pm$ 0.77	5.28 $\pm$ 1.19	2.18 $\pm$ 0.99	Balanced mesomorph
Boxing	3.66 $\pm$ 1.29	4.58 $\pm$ 1.04	2.81 $\pm$ 1.33	Endomorphic mesomorph
High jumping	2.73 $\pm$ 1.31	2.73 $\pm$ 1.32	4.89 $\pm$ 0.45	Balanced ectomorph
Weightlifting	2.89 $\pm$ 1.21	5.68 $\pm$ 1.52	2.26 $\pm$ 0.93	Endomorphic mesomorph
Wrestling	5.11 $\pm$ 2.33	5.70 $\pm$ 2.39	1.84 $\pm$ 0.98	Endomorphic mesomorph
Rowing	4.48 $\pm$ 1.64	5.38 $\pm$ 1.75	2.23 $\pm$ 0.67	Endomorphic mesomorph
Swimming	3.65 $\pm$ 0.75	4.52 $\pm$ 1.23	2.76 $\pm$ 0.91	Endomorphic mesomorph
Volleyball	3.09 $\pm$ 1.01	4.54 $\pm$ 1.73	3.08 $\pm$ 1.10	Balanced mesomorph
Tennis	3.60 $\pm$ 1.54	4.62 $\pm$ 0.83	3.27 $\pm$ 0.82	Balanced mesomorph
Football	3.75 $\pm$ 0.94	4.34 $\pm$ 1.98	3.16 $\pm$ 1.47	Endomorphic mesomorph, close to balanced mesomorph

The somatotype of the athletes, participating in karate WKF (3.67–5.27–2.85) and boxing (3.66–4.58–2.81), was classified as endomorphic mesomorph. Within these groups mesomorphy is dominant, endomorphy is

greater than in groups of gopak fighters and fencers, and greater than ectomorphy. However, the small difference between the endo- and ectomorphy levels (0.82 and 0.85 respectively) makes them close to balanced mesomorph (see Table 2).

The somatotype of high jumpers was very different from the other athletes. These tall (192.88 ± 2.98 cm) athletes had the high levels of height-weight ratio (HWR) (45.65 ± 0.60) and high ectomorphy level (from 4.1 to 5.8), which was much greater than endo- and mesomorphy. The average somatotype of high jumpers was 2.73–2.73–4.89 (balanced ectomorphy) (see Table 2).

The mesomorphy dominates in the somatotype of the athletes of strength and aquatic sports, being higher than for combat sports athletes. The good development of the skeleton and skeletal muscles was found for the weightlifters regardless of weight category. In this group the mesomorphy level of 10 athletes was higher than 5 and in some cases – reached 7–9. The endomorphy level was highly variable (from 1 to 6.8), while ectomorphy considered to be low (mainly from 1 to 2.3, only in one case – 3.7). It is in good agreement with total body size and HWR of weightlifters. The average somatotype of weightlifter was 2.89–5.68–2.26. This somatotype is defined as endomorphic mesomorph, but the very small difference between endo- and ectomorphy (0.63) makes it close to balanced mesomorph (see Table 2).

Wrestlers featured the relatively high levels of mesomorphy (5.70 ± 2.39) and endomorphy (5.11 ± 2.33). Hence, the both musculoskeletal and fat components of the body are highly developed. The difference between meso- and endomorphy is only 0.59. In contrast to other components, the ectomorphy is not high, caused by short stature and strong physique. The average somatotype of wrestlers is 5.11–5.70–1.84 – endomorphic mesomorph, close to the mesomorph-endomorph (see Table 2).

The somatotype of rowers is characterized by the high mesomorphy (5.38 ± 1.75) and higher than average endomorphy (4.48 ± 1.64) levels. The mesomorphy level was found to be high in the majority of rowers, in some cases it exceeded 7. The endomorphic component was highly variable – from 2.6 to 7.2. Only in two cases it was higher than 3. The average somatotype of rowers is 4.48–5.38–2.23 – endomorphic mesomorph (see Table 2). These results are in agreement with other authors (Krawczyk, B., Sklad, M., & Jackiewicz, A., 1997), who found the endomorphic mesomorph somatotype (4.65–5.20–1.70) for the rowers. The only difference is the greatest ectomorphy level in our subjects.

Within the athletes of strength and aquatic sports the smallest levels of mesomorphy was found in the group of swimmers (4.52 ± 1.23). They were characterized by moderate body fat component (3.65 ± 0.75). The average somatotype of the swimmers is 3.65–4.52–2.76 – endomorphic mesomorph (see Table 2).

Our results reveal the essential individual variations in the levels of different components of somatotype among the athletes of game sports. However, the mesomorph component was found to be dominant in this group. The mesomorphy level for players is lower, than for the athletes of strength and aquatic sports, but close to those of combat sports athletes. The average somatotypes of game players (see Table 2) are: volleyball – 3.09–4.54–3.08 (balanced mesomorph); tennis – 3.60–4.62–3.27 (balanced mesomorph); football – 3.75–4.34–3.16 (endomorphic mesomorph).

Discussion

The somatotypes analysis revealed the domination of the mesomorphy component for all subjects. This reflects the high development of the musculoskeletal component, especially the skeletal muscles. However, we have found the somatotypes peculiarities of the athletes of different sports. Mesomorphy was the highest among the athletes, who participate in wrestling (5.70) and weightlifting (5.68). Perhaps it is caused by the predominance of intensive strength static loads in their training process. Though some previous researches (Koropanovski et al, 2011; Krawczyk, Sklad, & Jackiewicz, 1997; Ramirez-Velez et al, 2014) found higher values of mesomorphy and lower levels of endomorphy for the high skilled wrestlers and other athletes of combat sports, all of them classified their somatotype as endomorphic mesomorph: Greco-Roman wrestling – 3.0–6.37–0.95; free-style wrestling – 2.73–6.47–1.03; judo – 3.34–6.77–1.14; sambo – 2.47–6.60–1.18. The prevalence of endomorphic mesomorph somatotype in the group of wrestlers is also confirmed in modern researches for Greco-Roman wrestling (2.2–6.8–1.1; Sterkowicz-Przybycień. Sterkowicz. & Żarów. 2011), wrestling (3.8–5.3–1.6; Ramirez-Velez et al. 2014) and free-style wrestling (2.47–6.07–1.41; Krawczyk. Sklad. & Jackiewicz. 1997). Thus, our results reveal the values of mesomorphy, that are very close to the findings of other researchers, while the endomorphy levels are found to be higher.

It was found that the endomorphy level of weightlifters was smaller than for wrestlers and was accompanied by low ectomorphy level. It is in good accordance with the results of modern researches, in which the somatotype of bodybuilders was classified as endomorphic mesomorph with the endomorphy level of 1.17 and mesomorphy – from 3.61 до 6.03 (Tóth, 2014). A small difference between endo- and ectomorphy of weightlifters, which have been observed in our study, shifts their somatotype towards the balanced mesomorph.

For rowers and swimmers the mesomorphy level was slightly lower, than for wrestlers and weightlifters, though their somatotypes were classified as endomorphic mesomorph (see Table 2). The lower mesomorphy level can be result of smaller proportion of static loads (which are known to be the effective stimulators of the hypertrophy of skeletal muscles and skeleton) in their training process. Previous researches

(Krawczyk, Sklad, & Jackiewicz, 1997) found the 2.86–4.27–2.93 (balanced mesomorph) somatotype for the skilled rowers, while some authors (Tzarova, 2013) classified somatotype of swimmers as mesomorph-ectomorph. We have found the greater level of meso- and endomorphy in our subjects, in comparison with the researches of other authors (Krawczyk, Sklad, & Jackiewicz, 1997, Tzarova, 2013).

Speed and strength loads are typical for the combat sport athletes. During their somatotype analysis relatively high levels of mesomorphy have been found. The endomorphy levels were slightly lower, than for the athletes of aquatic and strength sports. The ectomorph component was low. The mesomorphy (5.27) of subjects, who participate in karate WKF (endomorph mesomorph), was found to be very close to those, reported by other authors, although endomorphy (3.67) and ectomorphy (2.85) were slightly higher. These authors found out the 3.07–5.07–1.79 somatotype for the athletes engaged in karate (Krawczyk, Sklad, & Jackiewicz, 1997). Our data concerning the levels of ecto- and mesomorphy of boxers are in good agreement with those obtained by other researches – 2,23–4,35–2,91 (ectomorph mesomorph, Krawczyk, Sklad, & Jackiewicz, 1997) or 2,3–3,7–2,3 (balanced mesomorph, Noh et al, 2014), but we have found higher endomorphy level. We have defined the average somatotype of boxer as endomorphic mesomorph (see Table 2).

We have found the slightly smaller mesomorphy level for the subjects, participated in high jumping, as compared with those, that have been determined by other authors. Probably the cause of low mesomorphy level is small volume of the muscles of upper limb, shoulder and trunk, along with small bones breadths. The high jumpers' high stature and dolichomorph physique has been mainly genetically determined, their training process does not involve the intensive power loads, aimed at developing of the muscles of the upper part of the body.

There are some research that revealed the average somatotype for high jumpers – 2.2–4.1–4.4 (mesomorph-ectomorph) (Martirosov, 1998) and 2.1–4.7–3.4 (ectomorph mesomorph) (Malinowski & Bożiłow, 1997; Štepička, 1972).

Our results of the somatotype determination for volleyball players (see Table 2) are in good agreement with some other research – 2.8–4.8–3.0 (Martirosov, 1998) and 2.8–4.2–2.6 (Ramirez-Velez et al, 2014) (balanced mesomorph). The recent study showed that average somatotype for volleyball players is mesomorphic ectomorph – 2.16–3.31–4.09 (Krawczyk, Sklad, & Jackiewicz, 1997), for basketball players – ectomorphic mesomorph (2.0–4.5–3.5; Tóth, 2014). Our research showed the balanced mesomorph somatotype as average for tennis players with higher meso-, ecto- and endomorphy when compared with other research (2.3–3.2–2.7 – central somatotype; Raschka, & Schmidt, 2013). According to the literature sources, the somatotype of football player is 2.5–5.2–2.7 (balanced mesomorph; Koropanovski et al, 2011), with higher mesomorphy and lower endo- and ectomorphy, than we have found. The recent research showed, that typical somatotype of football player is 1.66–5.10–2.55 (Burdukiewicz et al., 2014), 2.4–4.8–2.3 (super league; Hazir, 2010) or 3.0–4.5–2.6 (first league; Hazir, 2010). Hence, our results of somatotype determination are close to those of the first league football players.

Conclusions

Our results suggest the significant increase of mesomorphy under the conditions of prevailing of speed and strength loadings in training process (combat sports, weightlifting, wrestling, rowing and swimming). The mesomorphy level for wrestlers, weightlifters and rowers (5.70 – 5.38) was higher than for the swimmers and athletes of speed-power sports. Within the athletes of combat sports the highest mesomorphy level was found for karate fighters (5.27 ± 1.05) and fencers (5.28 ± 1.26). The highest endomorphy has been found for the athletes, engaged in the sports without essential amount of vertical body movements (wrestling, rowing and swimming).

The mesomorphy prevails in the somatotype of athletes, who participate in volleyball, tennis and soccer. This is typical for all examined subjects (except the high jumpers). The ectomorphy levels for the game sport representatives and high jumpers are the highest among examined athletes. We can suppose the increase of ectomorphy in the case of high amount of the vertical jumping elements during competitive and training activity (games, high jumping). This is supported by the highest values of ectomorphy, obtained for high jumpers (from 4.1 to 5.8), for whom the ectomorphy was found to be higher than endo- and mesomorphy.

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