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Research article

ANALYSIS OF THE SOMATOTYPE OF TOP YOUNG RACE WALKERS BY MEANS OF THE HEATH-CARTER METHOD

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Abstract. *The aim of this study was to analyze the somatotypes of top young race walkers in Europe. For the analysis of their somatotype, the Heath-Carter method was used. By applying digital anthropometry and computer programs, the somatotypes of 44 participants aged 15 to 17, sports walkers of both genders (21 boys and 23 girls), were determined. Based on the analysis, extensive data were obtained on the somatotype of top young race walkers, where a large number of groups emerged. Among the boys, there are three groups of somatotypes: ectomorph-mesomorph (1.8-6.7-4.1), mesomorph-ectomorph (1.4-4.2-5.6) and mesomorph-ectomorph (1.7-5.1-5.1). The results showed that as many as 7 different groups of somatotypes can be found among the girls: endomorph-mesomorph (4.5-7.9-2.4), ectomorph-mesomorph (3.5-6.4-4.3), central (3.1-3.7-4.0), balanced mesomorph (3.5-6.0-3.6), balanced ectomorph (2.7-1.6-6.4), mesomorph-ectomorph (3.3-5.0-4.7), mesomorph-ectomorph (2.7-4.4-5.2). The analyzed somatotypes of top young race walkers indicate the considerable heterogeneity of the group of participants. The intermediate somatotype among the males is defined as ectomorph-mesomorph (1.7-6.1-4.5), whereas the intermediate somatotype among the females is defined as a central somatotype (3.5-5.5-4.0).*

Key words: *Somatotype, Body Composition, Sports Walking, Heath-Carter Method*

INTRODUCTION

Sports walking is an athletic discipline of cycle movement structure and is characterized by superhuman efforts in training and competitions. As such, it requires great sacrifice and talent of strong individuals who aim to achieve top results in this athletic event. It takes place at distances of 1, 2, 3, 5, 10, 20 and 50 km. Older pioneer and younger junior

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competitors perform at 3, 5 and 10 km on the road, as well as 3,000, 5,000 m 10,000 m on the track (stadium). For them this is a kind of mental load, because in sports walking, one of the dominant factors is the ability to maintain high concentration and coordination for extended periods of time, because the walker can be eliminated from the competition due to violations of walking rules. One of the more important factors and prerequisites for success in sport walking is the "composition" of walkers, i.e. the anthropological characteristics of walkers. One's somatotype is directly related to the proportions of the body, the amount of fat and lean body mass, and circular and transverse dimensions of the skeleton, and percentage of muscle mass of the body (Mišigoj-Duraković, 2008).

Today's understanding of the somatotype of top athletes of some sports are obtained on the basis of studies of Olympic Game participants. Several studies focused on examining the constitution of athletes, starting from the London Olympic Games in 1948 (Cureton, 1951), then in Rome in 1960 (Tanner, 1964), in Mexico in 1968 (DeGaray, Levine, & Carter, 1974). Carter (1984) published a concise summary and comparison of the measurements of Olympic Game participants from 1948 to 1976. The average fixed somatotype for the Olympians was 2-5-2.5 for men, and 3-4-3 for women. Half of the participants had a somatotype very close to these average values. Most elite athletes predominantly have a mesomorph structure and have a more pronounced mesomorphia and less pronounced endomorphia than women athletes. Analysis of the somatotype of athletes in national competitions shows the deviation from the central somatotype, which is characteristic of Olympic athletes with top results, as stated above, and range, depending on the sport discipline, from the dominant component toward one of the other two components. It is considered that the diversity of somatotypes in national sports, due to the differences in the technical equipment, race and ethnical origin of athletes, as well as their socio-economic status, training process and selection methods. There is greater diversity in terms of somatotypes among young athletes of both sexes, than among the older ones, while sexual dimorphism is lower among younger than older athletes (Bailey, Carter, & Mirwald, 1982; Carter & Parizkova, 1978).

The relevant data point out that anthropometric studies also involving somatotype show the diversity of athletes that depend on the type of sports activities and competition level. In sports dominated by strength characteristics we find the mesomorph component, as authors have shown in the case of Polish judokas with a somatotype 3.5-5,9-1,8, which is very representative (Lewandowska, Buśko, Pastuszak, & Boguszewska, 2011). The mesomorph component is related to individual sports which require muscle strength (Stanković, Pavlović, Petković, Raković, & Puletić, 2018; Hagner-Derengowska et al., 2014; Sterkowicz-Przybycień, Sterkowicz, & Żarów, 2011; Mathur, Toriola, & Igbokwe, 1985), and the ectomorph for group sports where precision and skill are required (Carvajal et al., 2012; Malousaris et al., 2008; Mathur et al., 1985).

Athletes usually present the mesomorph somatotype with modification to endomesomorph and mesoectomorph characteristics depending on the type of activity. The mesomorph component is associated with muscle strength, that is predominant condition for the successs in running, jumping and throwing activities (Stanković et al., 2018; Travill & Carter, 1993; Gottshall, Carter, & Moore, 1990).

Based on the aforementioned, the subject matter of this research is to define the scope of athletic disciplines in the population of top young walkers of Europe. The main goal of this research is to determine the somatotype (using the Heath-Carter method), to examine

the distribution of somatotypes and body composition of top young walkers, and based on that form groups of somatotypes. Based on the research results, we will attempt to define the specifics of the somatotype of young walkers and find a correspondence with the level of their abilities and potential for the development of the results of senior level competitors.

METHODS

The sample of participants

The sample consists of 44 healthy participants (21 boys and 23 girls) aged 15 to 17, who have been participating in sports walking for more than four years, and who have achieved excellent results at the national level. All of the participants live in Europe. The sample was analyzed at the camp for the young walkers Europe, which was held at the children's camp "Agios Andreas", Athens. The camp participants were talented young walkers, presenting a representative sample of their discipline. In addition, they were also the national champions of their country in their age categories, and their competition results were presented in IAAF points.

Measuring instruments

The measurements were taken in August 2011, over a period of 12 days. As the participants were all minors, parental consent was required. Before performing the experimental treatment, a complete medical examination was done and mandatory anthropometric measurements taken, so that only healthy participants were able to complete this exercise program till the end and with no consequences for health were invited to participate. The following variables were analyzed: Body height (BH) in cm; Body mass (BM) in kg; Four skinfolds Σ=KN (triceps, beneath the shoulder blade, abdomen, thigh) in mm; the diameter of the knee joint (DKJ) in cm; the diameter of the elbow joint (DEJ) in cm; the volume of the flexed upper arm circumference at 90% (VUA) in cm; the volume of the lower leg (VLL) in cm.

Anthropometric measures were obtained using an anthropometer and digital camera "Casio Exillim 10Mpix" (the digital photographs were later processed using the Image J computer software). Body mass was measured using the Terralion professional scale. The somatotype was calculated using the Heath-Carter method (Carter 1975) and the "Somatotype 1.0" program. It is expressed by three numbers representing the endomorph, mesomorph and ectomorph component, always in the same order.

The experimental treatment program in this study included the experimental transverse method. One measurer was engaged in taking skinfold measurements and photographing the participants, while the second measurer recorded data on the body mass of the participants.

Statistical Analysis

After the variable input, an analysis of the somatotype was conducted using a computer program. The average values and standard deviation of the somatotypes were analyzed, and certain groups were organized based on the results. The obtained results were presented in tabular form and in the form of a somatogram.

RESULTS WITH DISCUSSION

By analyzing the somatotypes of young walkers, the following results were obtained. They are presented in tables (1 and 2) and figures (1 and 2).

Table 1 Somatotype parameters in boys

Type and mean somatotype	N	%	Age (years)	BH±SD (cm)	BM±SD (kg)	∑= (KN) (mm)	DEJ (cm)	DKJ (cm)	VUA (cm)	VLL (cm)
ectomorph mesomorph 1.8-6.7-4.1	14	66.66	16.67 ± 2.39	172.85 ± 3.25	58.43 ± 4.42	19.64 ± 3.14	8.58 ± .47	11.42 ±. 40	26.95 ± 1.62	35.81 ± 2.10
mesomorph ectomorph 1.4-4.2-5.6	3	14.29	14.33 ± 1.53	176.33 ± 8.14	54.33 ± 8.96	15.87 ± 2.14	7.72 ± .82	11.20 ± .49	22.71 ± 2.14	32.97 ± 3.14
mesomorph-ectomorph 1.7-5.1-5.1	4	19.05	16.00 ± 1.41	175.00 ± 8.25	55.50 ± 9.40	18.80 ± 7.65	7.87 ± .15	11.42 ± .53	25.21 ± 2.81	33.56 ± .75
SUMA (∑)										
Mean somatotype Ectomorph-mesomorph 1.7-6.1-4.5	21	100	16.67 ± 2.39	173.76 ± 5.06	57.29 ± 6.07	18.94 ± 4.17	8.32 ± .59	11.39 ± .42	26.01 ± 2.39	34.98 ± 2.33

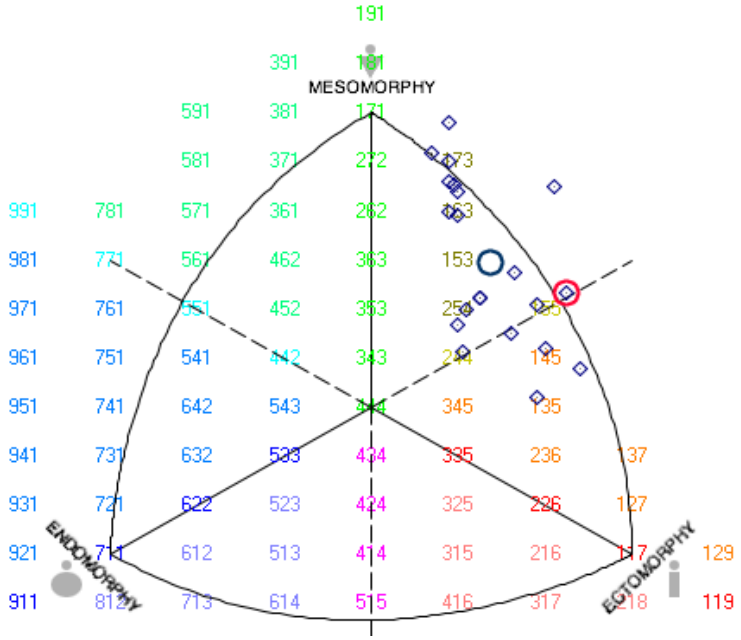

Fig. 1 Somatogram of somatotypes in boys

In this study, we analyzed the somatotypes of top young walkers, national champions. The results indicate a more pronounced heterogeneity of the group of participants. In fact, a large number of groups of different somatotypes emerged. Among the boys, three groups of

somatotypes were recorded: the ectomorph-mesomorph (1.8-6.7-4.1), mesomorph-ectomorph (1.4-4.2-5.6) and mesomorph-ectomorph (1.7-5.1-5.1) (Table 1).

This implies that the mean somatotype of the boys (SUMA) is of average body height (173.76±5.06cm), and body mass (57.29±6.07kg), which generally corresponds to the ectomorph-mesomorph somatotype (1.7-6.1-4.5). The average age of the walkers was 16.67±2.39. Of the total sample of male walkers, up to 66.66% were defined as ectomorph-mesomorph, so it can be concluded that it was crucial in the overall variance of somatotype of walkers. The mesomorph-ectomorph somatotype defined in 19.05% of the participants and mesomorph-ectomorph in only 14.29% of young walkers. However, this confirms the fact that the walkers have more of a leptosome body type than athletic, where longitudinal dimensions are dominant. The results of this study of a sample of male walkers are similar to the results obtained in previous studies on the population of other athletes of the same age (Sánchez-Muñoz, Sanz, & Zabala, 2007; Bagnall & Kellet, 1977; Mathur et al., 1985).

Table 2 Somatotype parameters in girls

Type and mean somatotype	N	%	Age (years)	BH±SD (cm)	BM±SD (kg)	∑= (KN) (mm)	DEJ (cm)	DKJ (cm)	VUA (cm)	VLL (cm)
Endomorph mesomorph 4.5-7.9-2.4	8	34.78	15.75 ± 1.91	160.50 ± 12.63	56.50 ± 6.99	41.31 ± 4.36	8.21 ± 0.54	12.03 ± .33	25.00 ± 2.27	36.20 ± 2.50
Ectomorph mesomorph 3.5-6.4-4.3	2	8.70	17.00 ± 2.83	165.00 ± 1.41	49.50 ± .71	33.20 ± 7.35	8.09 ± .41	11.18 ± .29	23.56 ± 1.11	35.72 ± .55
Central 3.1-3.7-4.0	1	4.35	14.00	164.00	50.00	29.2	6.46	10.41	20.41	32.93
Balanced mesomorph 3.5-6.0-3.6	4	17.39	16.25 ± 2.22	162.25 ± 8.58	50.25 ± 5.68	32.60 ± 5.36	7.43 ± .95	11.29 ± 1.08	24.14 ± 2.51	33.17 ± 3.87
Balanced ectomorph 2.7-1.6-6.4	4	17.39	15.25 ± 1.26	171.13 ± 3.92	46.25 ± 3.59	26.88 ± 7.97	6.52 ± .60	9.33 ± .26	21.20 ± 2.03	28.26 ± 1.82
Mesomorph-ectomorph 3.3-5.0-4.7	1	4.35	16.00	172.00	54.00	33.00	7.18	11.54	23.55	36.11
Mesomorph ectomorph 2.7-4.4-5.2	3	13.04	15.33 ± 2.52	164.00 ± 7.81	44.67 ± 5.86	24.40 ± 6.16	6.55 ± .53	10.59 ± 1.22	21.72 ± 1.97	33.23 ± 3.71
SUMA (∑) Mean somatotype central 3.5-5.5-4.0	23	100	15.74 ± 1.84	164.15 ± 9.26	51.09 ± 6.80	33.49 ± 8.19	7.43 ±.93	11.08 ± 1.14	23.37 ± 2.48	33.72 ± 3.76

When analyzing the girl walkers, 7 groups of somatotypes were extracted: 4.5-7.9-2.4 endomorph-mesomorph, ectomorph-mesomorph 3.5-6.4-4.3, 3.1-3.7-4.0 central, balanced mesomorph 3.5-6.0-3.6, 2.7-1.6-6.4 balanced ectomorph, mesomorph-ectomorph 3.3-5.0-4.7, 2.7-4.4-5.2 mesomorph-ectomorph. But heterogeneity in the group of girls can also be found. The average somatotype of the girls (SUMA) is one of the average body height (164.15±9.26cm), body mass (51.09±6.80kg), which generally corresponds to the central somatotype (3.5-5.5-4.0). The average age of the girls was 15.74±1.84. Of the total sample of women walkers, 34.78% of them were defined as endomorph-mesomorph (34.75%). In second place we find the balanced mesomorph and balanced ectomorph somatotype (17.39%). The mesomorph-ectomorph was defined in 13.04% of the girls, and the ectomorph-mesomorph in 8.70% of them. The central somatotype and mesomorph-ectomorph was defined in 4.35% of the female walkers (Table 2).

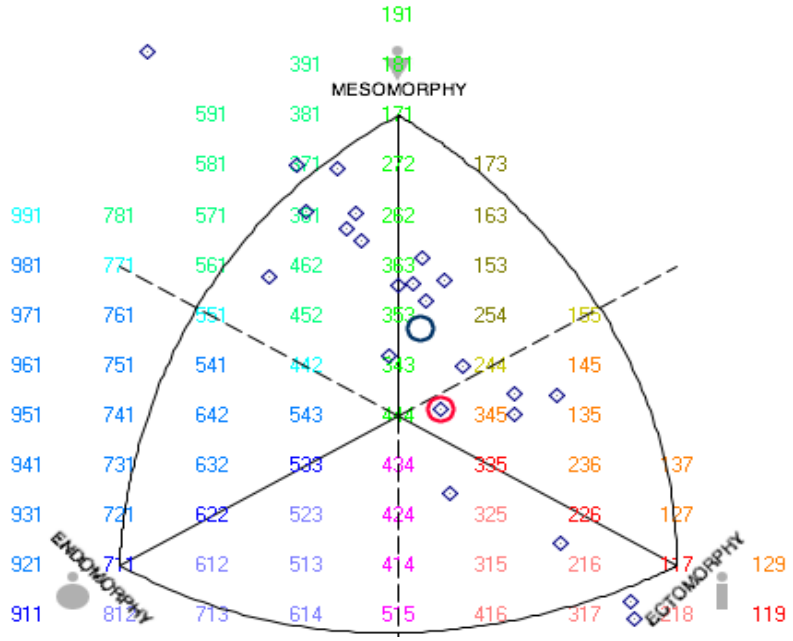

Fig. 2 Somatogram of somatotype in girls

Among the males, the most common type of somatotype is the ectomorph-mesomorph, in 66.66% of the participants, while among the females the endomorph-mesomorph type was determined in 34.78% of the participants. The mean somatotype in the case of the boys is ectomorph-mesomorph 1.7-6.1-4.5. It follows that in the walkers the mesomorph component (6.1) is prevalent, followed by the increased ectomorph-component (4.5). And as the least expressed component of the male walkers is the endomorph component (1.7). The mean somatotype of the girls is defined as the central somatotype (3.5-5.5-4.0). The leading component is mesomorph (5.5) while the ectomorph and endomorph components have almost similar values (3.5-4.0).

The recommended somatotype among the senior competitors is the ectomorph-mesomorph, but because the participants are still undergoing a growth spurt, one must be cautious with forecasts. In this age of intense growth, the somatotype changes dramatically from year to year (Milić et al., 2012). For this reason, it is necessary to follow this group of walkers in the future and indicate a possible large deviation from the model. The group of girls especially showed large deviations from the model, so it is necessary to engage a team of nutritionists in order to avoid the situation where an overly expressed endomorphic component hinders result improvement, as the presence of excess fat is directly related to the result of the sport walking.

Similar studies involving the somatotypes of participants of the same approximate age as in our sample of young walkers, but also that of other athletes were of interest to a large number of authors (Barbieri, Zaccagni, Cogo, & Gualdi-Russo, 2012; Diafas, Dimakopoulou, Diamanti, Zelioti, & Kaloupsis, 2011; Sterkowicz-Przybycień et al., 2011; Sánchez-Muñoz et

al., 2007). These are mainly studies that used the somatotype to determine the body proportions in a given sport, with the aim of monitoring the physical growth and development as an important prerequisite for sports, including somatotype traits in certain sports.

The obtained somatotypes of the male and female walkers can be compared to the somatotypes found in other individual and group sports. As far as individual sports are concerned, the somatotype is very important in gymnastics (Claessens, Lefevre, Beunen, & Malina, 2006) and rhythmic gymnasts (Di Cagno, Baldari, Battaglia, Guidetti, & Piazza, 2008). Track, field sprint and other running disciplines are mostly dominated by the mesoectomorph somatotype of athletes, as opposed to throwing discipline which are dominated by the mesoendomorph somatotype (Stanković et al., 2018; Vučetić, Matković, & Šentija, 2008; Carter, 1984). The analysis of high-class swimmers led to the conclusion that the mesomorph somatotype can be found, and that there are differences in terms of various styles of swimming. It has been indicated that the mesomorph somatotype of the boys with a tendency towards ectomorph components and the intensive training process change the somatotype toward the mesomorph component, with a reduction of endomorphism (Stanković et al., 2018; Bagnall & Kellett, 1977). In the research of Stager, the impact of somatic characteristics among male and female swimmers on the selection of prospective elite swimmers was studied on a sample of swimmers who participated in the Olympic Games and who scored top results from 1964 to 1995. It was concluded that the swimmers with top results are central somatotypes with a tendency toward decreasing endomorphic and increasing ectomorphic components. Somatotypes are applied in the selection of prospectivethe mean elite swimmers (Zuniga et al. 2010). Top mountaineers have similar motor and physiological demands as walkers. Among them, it is necessary to define and crystallize the appropriate somatotype which would be representative of this population. The mesomorph is the dominant somatotype component in all but one of the participants, endomorphism is low, and the body fat percentage is low. Elite mountain climbers were predominantly mesomorph with somatotype attitudinal mean values lower than reported for male athletes who participated in free-climbing, volleyball, gymnastics, and soccer (Barbieri et al., 2012). According to Puletić & Stanković (2014), the somatotype of sport climbers was ectomorph-mesomorph. Considering that all these are basic sports, along with athletics, the results are even more relevant for practical application. The research into the somatotype in other individual sports includes the somatotype of wrestlers, heavyweight category, characterized by the endomorph-mesomorph type, whereas lightweight categories are dominated by a balanced mesomorph (Sterkowicz-Przybycień et al., 2011). The mean somatotype of elite male junior tennis players could be defined as ectomesomorph while the mean somatotype of elite female junior tennis players is an endomesomorph one (Sánchez-Muñoz et al., 2007).

As far as some group sports are concerned, the somatotypology differs not only among sports, but also among various playing positions on the team. This has been determined among football players (Can, Yilmaz, & Erden, 2004), volleyball players (Milić et al., 2017; Milić, Grgantov, & Katić, 2012; Malousaris et al., 2008; Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006), basketball players (Bayios et al., 2006; Carter, Ackland, Kerr, & Stapff, 2005), handball players (Bayios et al., 2006) and others.

All research, including this study, aimed to determine the somatotype of specific populations of athletes which should represent an important segment of the overall

anthropological status of an athlete. Namely, through a precise specific somatotype, it is possible to use cybernetic models to act in the desired direction. Sometimes the goal is guiding the specialization of athletes, and sometimes the monitoring, diagnostics and effects of guiding the training process. Also, based on the somatotype of athletes, models that are specific to a particular sport can be identified. The somatotype can determine the dominant component of athletes in a particular sport, for example in the throwing events, some sports games, etc. This study has allowed us to obtain information on the somatotype of top young walkers. The results showed that a number of groups could be formed, in particular in women's competitions. The analyzed somatotypes of top young walkers indicated the considerable heterogeneity of both groups of participants.

CONCLUSION

The analysis of previous studies has led us to the conclusion that somatotype components are not homogeneous in many sports, even among groups that were singled out by their characteristics. Significant differences exist within the same sport, and in relation to the position played in the game. Especially in ball and team sports, while in individual groups somatotypes are more homogeneous with a higher level of athletic performance. The literature review showed the results of many comparisons of the somatotype of athletes in various sports. The drawn conclusions indicate a differentiation of sports based on somatotype, so these findings are important in the field of talent selection for top sport. Top athletes have significantly different body composition and somatotype from their sedentary peers. Many studies point to the undoubted tendency of modern sport where the athletes should be more mesomorph and less endomorph if they want to reach top results. This is especially relevant for athletics, gymnastics and volleyball, while women's handball is characterized by the highest endomorph component.

The somatotypes analyzed in this study of top young walkers indicate the homogeneity of the participating groups. Namely, there has been an emergence of a large number of groups where males appear in three groups: ectomorph-mesomorph (1.8-6.7-4.1), mesomorph-ectomorph (1.4-4.2-5.6) and mesomorph-ectomorph (1.7-5.1-5.1), while the girls recorded seven groups: endomorph-mesomorph (4.5-7.9-2.4), ectomorph-mesomorph (3.5-6.4-4.3), central (3.1-3.7-4.0), balanced mesomorph (3.5-6.0-3.6), balanced ectomorph (2.7-1.6-6.4), mesomorph-ectomorph (3.3-5.0-4.7), mesomorph-ectomorph (2.7-4.4-5.2). In men, the most common type of somatotype is ectomorph-mesomorph with a 66.66%, and among the women, endomorph-mesomorph is present with a 34.78%. The mean somatotype among men is ectomorph- mesomorph 1.7-6.1-4.5, while the mean somatotype of the girls is the central somatotype 3.5-5.5-4.0.

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ANALIZA SOMATOTIPA VRHUNSKIH MLADIH HODAČA POMOĆU HEATH-CARTER METODE

Cilj istraživanja bio je da se analizira somatotip vrhunskih mladih hodača Evrope. Za analizu somatotipa opredelili smo se za Heath-Carterovu metodu. Koristeći digitalni antropometar i kompjuterski program određen je somatotip 44 učesnika, hodača oba pola. Na osnovu analize dobijeni su opsežni podaci o somatotipu vrhunskih mladih hodača, gde je nastao veliki broj grupa. Kod muškaraca,određene su tri grupe somatotipa: ektomorfni-mezomorfni (1.8-6.7-4.1), mezomorfni-ektomorfni (1.4-4.2-5.6)i mezomorfni-ektomorfni (1.7-5.1-5.1). Rezultati pokazuju da je kod devojaka prisutno 7 različitih grupa somatotipa: endomorfni-mezomorfni (4.5-7.9-2.4), ektomorfni-mezomorfni (3.5-6.4-4.3), centralni (3.1-3.7-4.0), uravnoteženi mezomorfni (3.5-6.0-3.6), uravnoteženi ektomorfni (2.7-1.6-6.4), mezomorfni-ektomorfni (3.3-5.0-4.7), mezomorfni-ektomorfni (2.7-4.4-5.2). Analizirani somatotip kod vrhunskih mladih hodača upućuje na značajnu heterogenost grupe ispitanika. Intermedijalni somatotip kod muškaraca definisan je kao ektomorfni-mezomorfni (1.7-6.1-4.5), dok je intermedijalni somatotip kod devojaka definisan kao centralni somatotip(3.5-5.5-4.0).

Ključne reči: *somatotip, telesna kompozicija, sportsko hodanje, Heath-Carter metoda.*