Coll. Antropol. **43** (2019) 2: 119–126
Original scientific paper

Male Students Physique In Accordance With Heath-Carter Method

Mirosława Szark-Eckardt, Jerzy Eksterowicz, Marek Napierała

Kazimierz Wielki University, Bydgoszcz, Poland

ABSTRACT

The aim of this study is to use the Heath-Carter method to assess the physique of male students during the first year of physical education course. The investigation was carried out in a group of male students, inscribed in the first year physical education course at Kazimierz Wielki University. The anthropometric measurements were taken from a total of 56 men aged 20–24. From the obtained values the following parameters were calculated: fat content, Rohrer's index ($R = M/L^3$), Body Mass Index, (kg/m^2), Waist to Hip Ratio Index (WHR), Arm Muscle Circumference (AMC) and the somatotype components: relative fatness (endomorphy), body robustness (mesomorphy), and body slenderness (ectomorphy). The reults obtained showed that average fat tissue content in the examined group of male students was 10.15%, while the obtained somatotypes had lower than the average values for endomorphy – 2.49, mesomorphy – 4.66 and ectomorphy – 2.71. The highest significant relationships were found between body mass and other investigated traits and the lowest between body height and other traits.

Key words: *somatotype, male students, Body Mass Index, physical education, anthropometry*

Introduction

Human body construction or human somatotype can be assessed in different ways. On the one hand the assessment can be based on the general body size, body mass, length of torso and limbs, width and circumferences of particular organs and their mutual proportions, and also on the amount of the fat inside the body relative to non-fat body mass, water content etc. On the other hand, it is possible to use a special formula of a specified somatotype described by a chosen method. In the specialized literature many approaches to human body description can be found[1–5]. In most of them, the assessment is mainly based on the chosen parameters related to length, width, circumference and other variables. In the scientific investigations related to the size and shape of the human body, it is highly recommended to use verified research methods, as in a number of published works quite different views on the human body typology and its assessment can be found[6–8]. The Heath-Carter method of somatotyping based on anthropometric measurements is the most commonly one used in sports today[9]. It is a revised method previously described by Sheldon[10], and improved to take into account body composition. It provides assessment of the three body components termed endomorphy (the relative fatness), mesomorphy (the relative musculo-skeletal robustness) and ectomorphy (the relative slenderness of a physique). The obtained anthropometric values are subjected to the statistical elaboration, while the assessed somatotype is the result of each component saturation degree[11–14]. This somatotype method can be universally applied to both sexes and for all ages, and it is reproducible. The aim of this study is to use this method to assess the physique of male students during the first year of physical education course.

Materials and Methods

This investigation was carried out in a group of male students, inscribed in the first year physical education course at Kazimierz Wielki University. The physique measurements were taken during the summer training in a camp of Chomiąża Szlachecka, in Kuyavian-Pomerania Voivodeship. At the camp students had the possibility to meet new methods of performing the physical education classes in the field, using basic activities in fresh air (runs, group plays, ball games etc.). Additionally, they

Received for publication February 25, 2018

could also familiarize themselves with some activities which require the use of sport equipment to be performed (e.g. bicycles, rollers, poles, boats, kayaks, sailboats etc.). The main purpose of the summer camp was to show the multiplicity of various sport activities in the field, as well as some possibilities to use the landforms during any sport idea (hills, forests, valleys, water reservoirs), and finally, to raise awareness among students about many dangers which exist during such activities and to inform them about the ways to counteract them when they appear.

The anthropometric measurements were taken on the 13th of July 2016 in the afternoon hours, during the break from classes. A total of 56 men aged 20–24 took part in the investigation. They were dressed in sportswear (shirt and shorts). The following measurements were taken: body height (B–V), body mass, skinfold thickness: the arm triceps skinfold (TSF), subscapular skinfold (SCSF), suprailiac skinfold (SISF), elbow width (cl–cm), knee width (epl–epm), circumference of the arm, crus, waist and hips. From the obtained values the following parameters were calculated: fat content, Rohrer's index ($R = M/L^3$), Body Mass Index, (kg/m^2), Waist to Hip Ratio Index (WHR), Arm Muscle Circumference (AMC) and body composition components: fatness (endomorphy), body robustness (mesomorphy), and body slenderness (ectomorphy). All measurements were taken using the anthropometric tools from Siber Hegner & Co. Ltd (Switzerland): anthropometer, outside caliper, vernier caliper, and anthropometric tape. The measurements were taken by the same researcher, applying standard anthropometric methods according to the procedure of the International Biological Program. According to the accepted procedures, all measurements were taken at one time and each student was investigated in one go. For each research participant, a separate protocol was prepared. After that, the values were tabulated and calculated according to the procedures of Heath-Carter method[9]. The statistical analyses included the following parameters: average values, standard deviations, correlations between investigated variables, and regression coefficients separately for each component of the somatotype. For calculations, Statistica 12 program was used.

Results

The analysis of the data showed that the average fat tissue, considering body mass, in investigated male students was 10.5%. However, the parameters which describe the somatotypes reached values under the average, endomorphy (body fatness) 2.49, mesomorphy (body robustness) 4.66 and ectomorphy (body slimness) 2.71 (Table 1). Figure 1 shows somatotype categories as represented on the somatochart.

In Table 2 the results of the correlation analysis between the examined variables are shown. The Pearson correlation coefficient was used to find out linear relations between the variables, where increase of one feature value results in proportional changes in another feature value. The following values were determined:

<0.2 – weak correlation (virtually no relation)
0.2 – 0.4 – low correlation (explicit relation)
0.4 – 0.6 – moderate correlation (important relation)
0.6 – 0.8 – high correlation (substantial relation)
0.8 – 0.9 – very high correlation (large relation)
0.9 – 1.0 – almost total correlation

The highest correlations obtained between investigated variables were those related to body mass. There was no correlation between body height and other comparing features.

The multiple linear regression analysis was performed for each somatotype category separately. From the analysis of the graphic model of the multiple linear regression for endomorphy (Figure 2), it can be conclud-

TABLE 1

BODY MEASURES OF INVESTIGATED STUDENTS

Traits	Averages	Me	Min	Max	Variance	s	v
Body height	181.4268	180.3500	167.9000	203.0000	49.1659	7.01184	3.86483
Body mass	77.7214	75.8500	57.4000	116.0000	118.5581	10.88844	14.00957
Fat tissue (%)	10.1526	9.7698	5.5956	21.0641	10.8263	3.29033	32.40882
Rohrer's index	1.3032	1.2600	1.0700	1.7600	0.0312	0.17669	13.55785
BMI	23.6003	22.9308	19.2980	32.9956	8.8111	2.96835	12.57759
WHR	0.9041	0.9020	0.8333	1.0108	0.0011	0.03283	3.63101
AMC	28.6929	28.5387	24.2706	34.5508	5.7734	2.40279	8.37415
Endomorphy	2.4911	2.5000	1.5000	6.0000	0.8317	0.91200	36.61060
Mesomorphy	4.6607	4.0000	3.0000	8.5000	1.5373	1.23989	26.60309
Ectomorphy	2.7054	3.0000	0.5000	5.0000	1.5798	1.25690	46.45954

Rohrer's index – degree of slimness; BMI – Body Mass Index; WHR – Waist to Hip Ratio (ratio); AMC – Arm Muscle Circumference – nutrition protein index.

TABLE 2

THE CORRELATION BETWEEN INVESTIGATED VARIABLES

Traits	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Body height	0.4624	–0.0985	–0.0679	0.1995	–0.2142	–0.3677	–0.0472	–0.1423	0.2640
2. Body mass	1.0000	**0.8347**	**0.7820**	**0.6061**	**0.5057**	**0.6496**	**0.7867**	**0.6981**	**–0.5601**
3. Fat tissue (%)		1.0000	**0.9178**	**0.5692**	**0.7077**	**0.9605**	**0.9064**	**0.8754**	**–0.7806**
4. Rohrer's index			1.0000	0.4150	**0.5632**	**0.8743**	**0.9793**	**0.7487**	**–0.7220**
5. BMI				1.0000	0.4087	0.4780	0.3716	**0.7020**	–0.4318
6. WHR					1.0000	**0.7255**	**0.5850**	**0.6980**	**–0.5282**
7. AMC						1.0000	**0.8560**	**0.8565**	**–0.7934**
8. Endomorphy							1.0000	**0.7409**	**–0.7081**
9. Mesomorphy								1.0000	**–0.7565**
10. Ectomorphy									1.0000

Rohrer's index – degree of slimness; BMI – Body Mass Index; WHR – Waist to Hip Ratio (ratio); AMC – Arm Muscle Circumference – nutrition protein index.

ed that 96.5 % of variable values were explained by the applied model. The R^2 value is an index, which describes the quality of matching the model to data. The value of R^2, nearly reaching 1.0, shows that almost all dependent variables can be explained by independent variables included into the model. From Table 2 it can be seen that the statistically significant independent variables are Rohrer's Index (p=0.000000) and Body Mass Index (p=0.027058).The remaining 3.5 % refers to independent variables without statistical significance, From this data it can be concluded that for the determination of the somatotype category of endomorphs, only Rohrer's Index and Body Mass Index need to be measured (Table 3, Figure 2).

From the analysis of the graphic model of the multiple linear regression for mesomorphs it can be seen, that 83.5 % of variable values are explained by mesomorphy and other variables (Figure 3). The value of R^2 is again almost reaching 1.0, which indicates that almost all dependent variables may be explained by independent variables included into the model. This analysis shows that the only statistically significant independent variable is Body Mass Index (p=0.000031). The remaining 16.5 % of independent variables demonstrate no statistical significance. From this, it may be concluded that for the determination of the somatotype category of mesomorphs, only Body Mass Index should be determined (Table 4, Figure 3).

The analysis of the graphic model of the multiple line regression for ectomorphs shows that 64.9 % of variable values are explained by ectomorphy and other variables (Figure 4). The R^2 value, like in the two previously described models, is again close to 1.0, which indicates that the model fits data well, and that almost all dependent variables can be explained by independent variables included into the model. In this analysis, the only statistically significant independent variable is Body Height (p=0.010391). The remaining 35.1% of independent vari-

TABLE 3

REGRESSION RESULTS FOR ENDOMORPHY AND BODY TRAITS

Dep.Var.8 Particip. 56	Multiple R = .98467509 Correct. R2 = .96514951		F = 218.5957 p = 0.000000	R^2 = .96958503 Est. stand. error: .170254050	df = 7.48	
	b*	St. Error from b*	b	St. Error from b	T (14)	p
Absolute term			9.73491	5.670390	1.71680	0.092464
Body height	–0.482070	0.243958	–0.06270	0.031730	–1.97604	0. 053913
Body mass	0.740299	0.615699	0.06201	0.051570	1.20237	0. 235118
Fat tissue (%)	–0.136088	1.185488	–0.04181	0.364230	–0.11480	0. 909086
Rohrer's index	**0.892476**	**0.071655**	**0. 24737**	**0.019861**	**12.45510**	**0. 000000**
BMI	**–0.080694**	**0.035384**	**–0. 03063**	**0.013430**	**–2.28052**	**0. 027058**
WHR	0.071485	0.038885	1.98592	1.080276	1.83835	0. 072203
AMC	–0.465137	0.788442	–2.40086	4.069641	–0.58994	0. 557995

Rohrer's index – degree of slimness; BMI – Body Mass Index; WHR – Waist to Hip Ratio (ratio); AMC – Arm Muscle Circumference – nutrition protein index

* significant b are highlighted

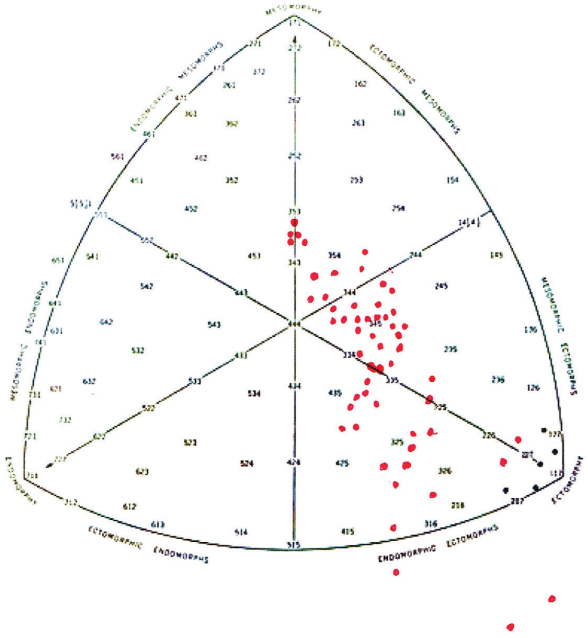

Fig. 1. Adapted somatogram with marked points which correspond to investigated male students.

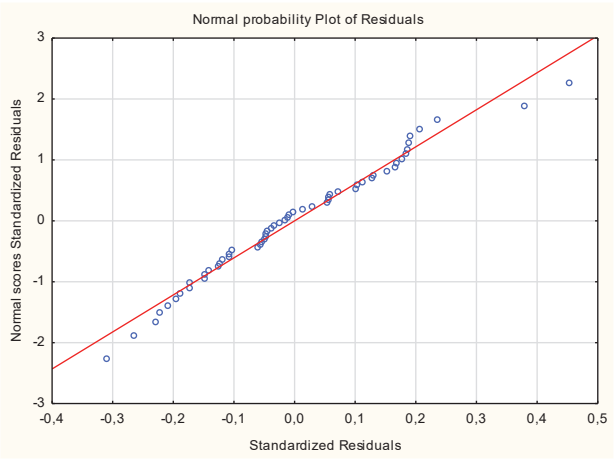

Fig. 2. Graphic model of linear regression for endomorphy and body traits.

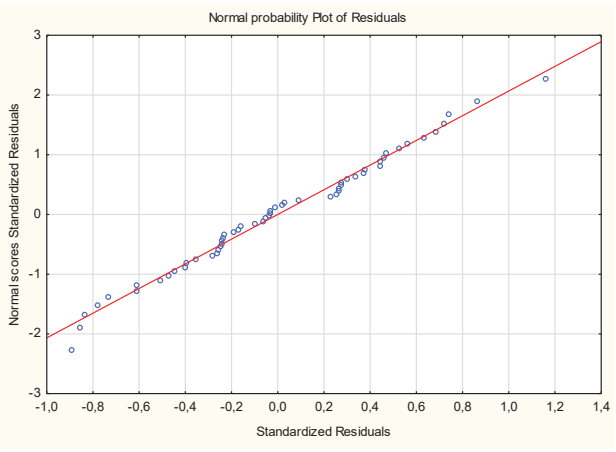

Fig. 3. Graphic model of linear regression for mesomorphy and body traits.

ables show no statistical significance. Considering the above, it can be deducted, that for the determination of the somatotype category of ectomorphs, it is enough to measure Body Height (Table 5, Figure 4).

Discussion

Previous research carried out by the authors[8] described the somatic physique of female students enrolled in the first year physical education course. The observed average fat tissue content in that group was around 13.56%, considering body mass. However, parameters which charac-

TABLE 4

REGRESSION RESULTS FOR MEZOMORPHY AND BODY TRAITS

Dep.Var. 9	Multiple R = 92507282		F = 40.68258	R^2 = .85575971	df = 7.48	
Particip. 56	Correct. R^2 = .83472467		p = 0.000000	Est. stand. error: .504067441		
	b*	St. Error from b*	b	St. Error from b	T (14)	p
			6.149196	16.78820	0.366281	0.715765
Body height	–0.518765	0.531268	–0.091733	0.09394	–0.976466	0.333729
Body mass	0.809904	1.340813	0.092226	0.15268	0.604040	0.548662
Fat tissue (%)	–0.296523	2.581645	–0.123859	1.07837	–0.114858	0.909037
Rohrer's index	–0.040691	0.156045	–0.015334	0.05880	–0.260765	0.795389
BMI	**0.354286**	**0.077056**	**0.182819**	**0.03976**	**4.597764**	**0.000031**
WHR	0.114916	0.084681	4.340316	3.19835	1.357049	0.181113
AMC	0.207258	1.716996	1.454422	12.04890	0.120710	0.904425

Rohrer's index – degree of slimness; BMI – Body Mass Index; WHR – Waist to Hip Ratio (ratio); AMC – Arm Muscle Circumference – nutrition protein index.
* significant b are highlighted

TABLE 5

REGRESSION RESULTS FOR ECTOMORPHY AND BODY TRAITS

Dep.Var. 10	Multiple R = .83269735	F = 15.50686	R^2 = .69338487	df = 7.48	
Particip. 56	Correct. R2 = .64867017	p = 0.000000	Est. stand. error: .745001338		
	b*	St. Error from b*	b	St. Error from b	T (14)	p
Absolute term			–57.4911	24.81261	–2.31701	0.024815
Body height	2.06610	0.774582	0.3704	0.13885	2.66738	0.010391
Body mass	–2.72741	1.954887	–0.3148	0.22566	–1.39517	0.169386
Fat tissue (%)	0.59362	3.764004	0.2514	1.59380	0.15771	0.875348
Rohrer's index	–0.04573	0.227511	–0.0175	0.08691	–0.20099	0.841559
BMI	–0.11837	0.112347	–0.0619	0.05877	–1.05362	0.297334
WHR	0.06350	0.123464	2.4314	4.72709	0.51435	0.609367
AMC	1.21859	2.503357	8.6687	17.80802	0.48678	0.628627

Rohrer's index – degree of slimness; BMI – Body Mass Index; WHR – Waist to Hip Ratio (ratio); AMC – Arm Muscle Circumference-nutrition protein index.
* significant b are highlighted

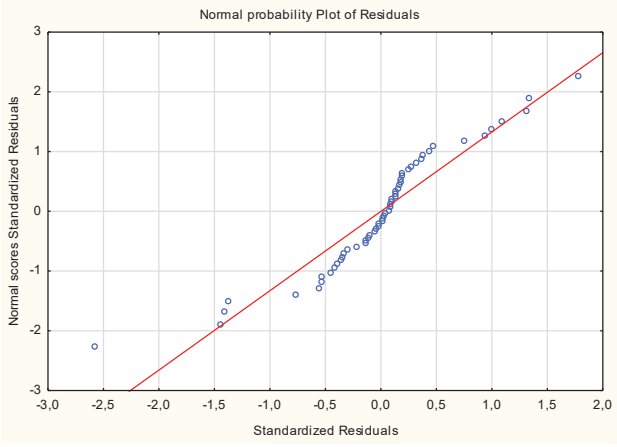

Fig. 4. Graphic model of linear regression for ectomorphy and body traits.

terize somatotype reached lower values than the average: endomorphy 3.59, mesomorphy 3.52, ectomorphy 2.78. The investigated students' physique was classified as slender, low-fat and not very strongly built. When compared to data on male students presented in this paper it can be seen that male students had lower fat content (10.5%), lower values of both endomorphy (2.49) and ectomorphy (body slimness) 2.71, but a higher value of mesomorphy (4.66) than the previously examined female students.

In the study Martínez et al.[6], tried to investigate the somatic parameters in 36 young semi-professional Caucasian swimmers (22 boys and 14 girls). It was found that the somatotype was twice as big for girls than for boys, probably due to different food habits and consumption of different nutritional values.

The most widely applied method for obtaining the somatotype is the anthropometric method of Heath and Carter, particularly in sports. Thus, in the research carried out by Sánchez-Muñoz, Sanz and Zabala[1] anthropometric features, body composition as well as somatotype were measured in the homogenous group of 123 male and female tennis players, comparing the anthropometric data, physique and somatotype of 12 best ranking junior tennis players with those at lower ranking positions in order to establish the anthropometric profile for the junior ranking elite. The study included players who regularly play in the tournaments sanctioned by Western Australian Lawn Tennis Association. In the study no significant differences were found for body height and body mass between 12 best ranking players and their colleagues lower on the ranking list. However, it was found that best 12 female players were much higher than girls with lower ranking. Significant differences in humerus width were also found between the best first and second ranking female players. The average (SD) somatotype in elite juniors tennis players was defined as ectomorphic (2.4 (0.7), 5.2, (0.8), 2.9, (0.7) and average SD of somatotype for that group could be defined as endomorphic (3.8 (0.9), 4.6, (1.0) 2.4 (1.0). It is also worth mentioning that no significant differences were found in the somatic components between the best 12 players and worse players by gender.

Dixson et al.[2] carried out five studies on physique determination and sexual attractiveness among males and females from New Zealand and California. In the first 3 studies women were asked to judge the pictures of male stimulus. Women from both countries judged as more attractive mesomorphic (muscular) stimulus and medium male somatotypes, than ectomorphic (slim) and endomorphic (strongly built) ones. In next two studies men judged the attractiveness of female pictures differing in waist to hip ratio (WHR) (from 0.5 till 1.0). The WHR value of 0.7 was judged as the most attractive in New Zealand and the value of 0.6 in California.

The study carried out by Lowery et al.[3] analyzed the relationships between self-esteem, body image and health behaviors, and its results showed strong correlations between investigated variables and important differences by gender.

The study carried by Szark-Eckard et al.4 aimed to define the somatic features and motor skills in 54 10-year old pupils of primary school in Bydgoszcz. Two groups of children were investigated, swimmers and non-swimmers. Five trials based on the international physical fitness test were performed to assess motor skills, strength, agility, speed, stomach muscles strength and flexibility. Body height, body mass, BMI and Rohrer's index were used to assess the somatic features. The results showed that children who were regular active swimmers had better physical fitness than non-swimmers, but no difference between the two groups was found for somatic features.

Recent research carried out by Eksterowicz, Napierała and Żukow[5] on the relationship between the somatic physique and sport results in runners from Kenya, showed that physique and body composition for long distance runners were quite homogenous and that they could be characterized as a very small body-size group. It was also found that some of somatic features such as foot width, length of the trunk and forearm length could have an important influence on the obtained results in the long distance runs.

Another anthropometric study[7] determined the body composition in a group of girls (52 participants with an average age of 13.9) with scoliosis (average scoliosis curvature 27°). None of the researched girls with spine condition underwent any treatment or surgery due to the spine. The control group consisted of 92 girls with no spine deformation, adjusted to the first group by age (average 13.9). In this research it was observed that in comparison to the control group, girls with scoliosis problem had significantly less average body mass, lower BMI and smaller percentage of fat tissue. From the group of 52 girls with spine scoliosis, 11 of them (21.2%) had BMI parameter lower than 17.5, which is recognized as a bordering value for anorexia. In contrast, in the control group only 3 out of 92 girls (3.3%) had BMI lower than 17.5. Moreover, the somatotype was different between these both groups: higher values were obtained for ectomorphic component (3.29 ± 1.68 in comparison with the control group 2.40±1,11 $p < 0.001$) and lower in the mesomorphic component (2.86 ± 0.82 in comparison to control group 3.70 ± 1.11, $p<0.001$).

The study by Bayios et al.[11] tried to determine the anthropometric profile, physique and somatotype for 518 Greek female basketball players (B), volleyball players (V) and handball players (H), all of them members of the First National League. 12 anthropometric measurements were taken, all necessary to determine the body composition and somatotype components. The obtained results showed that volleyball players were definitely the highest and had the lowest fat tissue values. Their somatotype was characterized as balanced endomorph (3.4–2.7–2.9). On the other hand, basketball players were higher and slimmer than handball players, with the somatotype described as mesomorph-endomorph (3.7–3.2–2.4). Handball players were the shortest, but they had the highest value of fat tissue content, and their somatotype was characterized as mesomorph-endomorph (4.2–4.7–1.8).

The study conducted by Carter et al.[12] compared the somatotype and body size in the group of female basketball players from 14 countries, based on anthropometric measures taken before the Women's World Championship in basketball in Australia, in 1994 year. As the results clearly showed, mean somatotypes by position were significantly different. Guards had greater mesomorphy than centres and less ectomorphy than forwards and centres. Players who played as guards were characterized by somatotype in the range of 2.9–3.9–2.6, while forwards had the somatotype 2.8–3.5–3.2.

Another investigation[14] was concerned with the somatic body build and skills needed to keep dynamic body-balance in female athletes, aged 8–11, who practice artistic gymnastics. To assess the somatotype in this group the Heath-Carter method[9] was used, based on the classic conception of the 3 components taken from Sheldon body structure[10]. The average values for the somatotype components in artistic gymnasts were 2.65±1.29 for endomorphy, 2.45±0.37 for mesomorphy and 3.95±0.64 for ectomorphy. The average Body Mass Index (BMI) in that group was 15.32, what indicates advanced slimness.

The same method was applied in the research[15] on Polish badminton players from top rated teams, which showed that the somatotype which characterized this group of sport players had values in the range of 3.0 : 3.0 : 2.5. Body mass, body height and BMI parameters for them were higher in comparison to most badminton players from other countries.

The results obtained by a study[16] on mixed male and female groups who engage in sports and those sports-inactive, aged between18–36, showed that BMI parameters were significantly higher in the sports inactive group than in participants who were active in sports.

The analysis of the results from the study conducted by Szafraniec[17] indicated some differences by residence in the somatic body structure of female students from the University of Rzeszów. Most of them were characterized by the leptosomatic body structure. However, students who lived in the villages had wider shoulders, larger chest circumference and were much heavier in comparison to students who lived in the cities. Additionally, women, who were characterized by pyknic body structure, were the first to reach their adolescence period while those with the leptosomatic body structure were the latest.

The research results collected by other authors[18] among women who professionally engage in sports in the United States showed that these female athletes face the paradoxical challenge of acquiring a degree of muscularity to be successful in their sport, yet they also endure pressure from societal expectations of femininity that often do not conform with the notion of muscularity. The above research included 221 participants of both sexes, divided in 3 groups: women-athletes-students, women-students, men-athletes-students. The obtained results and their analyses showed that women-students wanted to be muscular for the following reasons: functionality (45%), health (42%), external satisfaction (21%), internal satisfaction

(18%). Only 16% of female student-athletes did not want to be muscular, whereas every male student-athlete reported a desire to be muscular. The authors indicate that the results of this study can be used to better understand the unique drive for muscularity among athletes, particularly female college student-athletes who live the paradox of negotiating societal standards of femininity with this desire to be muscular[18].

The main goal of another important investigation carried out by Genovese and Little[19] was to examine a relationship between mesomorphy and experiential cognitive style in the group of university students (30 women and 24 men). Anthropometric somatotypes were obtained by using the Heath-Carter method. The results showed that there were significant correlations between mesomorphy and experiential cognitive style for men (r(s) = .33) and women (r(s) = .25). For men, experiential cognitive style was also correlated with endomorphy (r(s) = .39) and ectomorphy (rs = –.48).

Another study[20] tried to determine the degree of movement limits for women in the over 65 years of age with metabolic syndrome in comparison with a matched group without metabolic syndrome. It found that better test results had women without the above syndrome, although all investigated women represented the same somatotype.

Korean authors Noh et al.[21] demonstrated that taekwondo athletes had higher values of ectomorphic components than not-athletes. However, both endomorphic and mesomorphic components were lower than in not-athletes persons.

Yavuz[22] compared anthropometric traits and physical fitness in 2 groups of female volleyball players (teenagers aged around 14), who took part in the national tournaments (both groups with different levels of sport results and achievements). In the study 60 volleyball players volunteers took part. Anthropometric measurements were used to determine the anthropometric and somatic characteristics as well as tests for physical fitness including hand strength, legs and back strength, flexibility, inclination in the knee, vertical jump, 20m sprint and ergo-spirometry. Players from the second group, with worse sport results, had endomorphic values significantly higher ($p < 0.05$), than players from first group with better sport results. Successful volleyball players had a clearly defined somatotype profile with ectomorphic component and lower fat tissue content.

Finally, Francique[23] investigated the prevalence of obesity among the university black-skin female students, with an attempt to find out how Black female students', who attended a predominantly White university in the United States, adopted physically active lifestyles and used campus recreational facilities. It was found that most of black-skin female students represent the endomorphic somatotype (visible obesity). The obtained results showed that 75.5% of the participants were followed the guidelines for regulation of obesity and physical activity, though interestingly 77.1% utilize the campus recreation facility fewer than two days per week. The findings suggest the sociocultural environment as the most influential factor on Black female students' relationship with physical activity, obesity and campus recreation facility usage[23].

Summarizing the results of all the above studies, it can be said, that human physique definitely depends on the genotype, widely understood environmental conditions, behavior and lifestyle during life. A very important factor is also health throughout ontogeny.

Conclusions

The purpose of this paper was to explore the use of the Heath-Carter method for the determination of the somatotype of male students enrolled in the first year university course of physical education. The results obtained showed good fit of data to the statistical models applied and confirmed the usefulness of the method. The following conclusions can be drawn:

1. The average fat tissue content in the examined group of male students was 10.15%, while the obtained somatotypes had lower than the average values for endomorphy (fatness) – 2.49, mesomorphy (robustness) – 4.66 and ectomorphy (slimness) – 2.71.
2. The highest significant relationships were found between body mass and other investigated traits and the lowest between body height and other traits.
3. In the regression for endomorphy and other traits, the significant variables were Rohrer's index and Body Mass Index. Thus, according to the applied method, to determine the endomorphic somatotype it is enough to measure Rohrer's index and Body Mass Index.
4. In the regression analysis for mesomorphy and other traits the only significant variable was Body Mass Index. To determine the mesomorphic somatotype, only Body Mass Index could be used.
5. The regression analysis for ectomorphy showed that the most significant variable was body height. Thus, according to the applied method, to determine the ectomorphic somatotype it is enough to measure body height.

REFERENCES

1. SÁNCHEZ-MUÑOZ C, SANZ D, ZABALA M, Br J Sports Med, 41(11) (2007) 793. DOI: 10.1136/bjsm.2007.037119. — 2. DIXSON BJ, DIXSON AF, BISHOP P, PARISH A, Arch Sex Behav, 3 (2010) 798. — 3. LOWERY S, KURPIUS S, BEFORT C, BLANKS E, SOLLENBERGE SR, FOLEY-NICPON M, Journal of College Student Development (JCSD), 46 (2005) 612. DOI: 10.1353/csd.2005.0062. — 4. SZARK-ECKARD M, NAPIERALA M, EKSTEROWICZ J, ŻUKOW W, ŁUKASZEWSKI R, Coll Antropol, 41 (2017) 231. — 5. EKSTEROWICZ J, NAPIERAŁA M, ŻUKOW W, Hum Mov, 1(17) (2016) 8, DOI: 10.1515/humo-2016-0002. — 6. MARTÍNEZ S, PASQUARELLI B, ROMAGUERA D, ARASA C, TAULER P, AGUILÓ A, J Strength Cond Res, 25 (4) (2011) 1126. DOI:10.1519/JSC.0b013e3181d4d3df. — 7. BARRIOS C, CORTÉS S, PÉREZ-ENCINAS C, ESCRIVÁ M, BENET I, BURGOS J, HEVIA E, PIZÁ G, DOMENECH P, Spine, 35 (4) (2011) 1470. DOI: 10.1097/BRS.0b013e3181f55083. — 8. EKSTEROWICZ J, NAPIERALA M, ŻUKOW W, Coll Antropol, 41 (2) (2017) 143. — 9. HEATH, BH, CARTER, JEL, American Journal of Physical Anthropology, 27 (1967) 57. — 10. SHELDON W, The Varieties of Human Physique: An Introduction to Constitutional Psychology. (New York: Harper & Brothers, 1940). — 11. BAYIOS L, BERGELES N, APOSTOLIDIS N, NOUTSOS K, KOSKOLOU M, J Sports Med. Phys Fitness, 46 (2) (2006) 271. — 12. CARTER J, ACKLAND T, KERR D, STAPFF A, J Sports Sci, 23, (10) (2005) 1057, DOI:10.1080/02640410400023233. — 13. SOBCZYK M, thematical Statistics (Wydawnictwo C.H. Beck, Warszawa 2010). — 14. POLISZCZUK T, BRODA D, Diabetes and Metabolism, 16, (2) (2010) 94. — 15. POLISZCZUK T, MOSAKOWSKA M, Polish J Sport Med, 26 (1) (2010) 45. — 16. ČABRIĆ M, KRAKOWIAK H, KRAKOWIAK A, Medical and Biological Sciences, 24/1 (2010) 19. — 17. SZAFRANIEC D, Zeszyty Naukowe Acta Biologica.Uniwersytet Szczeciński, 728 (2012) 5. — 18. STEINFELDT JA, CARTER H, BENTON E, STEINFELDT MC, Sex Roles, 64 (7) (2011) 543. — 19. GENOVESE JE, LITTLE KD, The Journal of Genetic Psychology, 172 (4) (2011) 433, DOI: org/10.1080/00221325.2010.536274. — 20. MARTÍNEZ PYO, LÓPEZ JAH, Int. J. Morphol, 30 (2) (2012) 637, DOI: org/10.4067/S0717-95022012000200046. — 21. NOH JW, KIM JH, KIM J, J Toxicol Environ Health Sci, 5 (3) (2013)163, DOI:10.1007/s13530-013-0170-9. — 22. YAVUZ SC, Anthropologist, 21(3) (2015) 427. — 23. CARTER-FRANCIQUE AR, Sport, Education and Society, 16(5) (2011) 553. DOI: org/10.1080/13573322.2011.601136.

M. Szark-Eckardt

Kazimierz Wielki University, Jana Karola Chodkiewicza 30, 85-064 Bydgoszcz, Poland
e-mail: szark@ukw.edu.pl

PROCJENA TJELESNE GRAĐE MUŠKIH STUDENATA PREMA HEATH-CARTEROVOJ METODI

SAŽETAK

Cilj rada je ispitati primjenu Heath-Carterove metode u procjeni tjelesne građe studenata prve godine studija tjelesnog odgoja na Sveučilištu Kazimierz Wielki u Poljskoj. Istraživanje je provedeno u skupini od 56 muških studenata u dobi između 20 i 24 godine. Na temelju prikupljenih antropometrijskih mjera izračunate su vrijednosti za postotak masnog tkiva, Rohrerov indeks, indeks tjelesne mase, omjer struka i bokova, opseg mišića ruke te komponente somatotipa: relativna masnoća (endomorf), mišičavost i masivna građa (mezomorf) i mršavost (ektomorf). Dobiveni rezultati pokazuju da je prosječna vrijednost masnog tkiva u studenata bila 10,15%, a vrijednosti svih somatotipskih kategorija bile su niže od prosječnih (endomorf – 2,49, mesomorf – 4,66 i ektomorf – 2,71). Statistički značajne povezanosti utvrđene su između tjelesne mase i drugih varijabli, dok se visina pokazala kao manje značajan faktor.