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The Assessment of the Female Student Physique in Accordance with Heath-Carter Method

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ABSTRACT

Purpose – The aim of this research is to determine the basic morphologic parameters of body composition, with particular emphasis on Body Type evaluation, according to Barbara Heath and Lindsay Carter method. Methods – The basic anthropometric measurements were taken in June 2016, during the summer training camp for Kazimierz Wielki University students. The study includes only measurements on female students, from first year of studies, Physical Education course. For the measurements the set of Swiss anthropometric tools were used, from Siber Hegner & Co. Ltd (Switzerland). All measurements were taken by the same investigator, applying standard anthropometric methods according to the procedure of the International Biological Program. Results – The analysis of the results shows, that the average content of the fat tissue to body weight, among the surveyed women, was 14,097%, however the parameters which characterize somatotype were lower than average values and amounted respectively: endomorphy (measurement of fatness): 3,59, mesomorphy (measurement of body massiveness): 3,52 and ectomorphy (measurement of body slenderness): 2,78. Conclusions The presented measurements show that studied bodies were in the group of medium slim, medium low fatness and medium strong body massiveness.

Key words: *somatic, Heath-Carter method, Sheldon method*

Introduction

Speaking about human body-build and composition, we use few definitions, such as: morphology, somatic and body construction. Those terms are very often used interchangeably, proceeding on the basis that they are all equal. The problematic aspects in human body-building systematics, where some of somatic values are indicated, has seen many development studies[1,2,3,4]. Using some simplifications, we are able to point out basic body characteristics and features:

Morphologic – informing about the body shape, size and appearance, as well as current condition and evolution level of basic tissue

Physiological – giving the basic informations about body systems and main processes

Pathological features and anomalies – showing the abnormalities in human body-building and functioning.

In the most typological systems the above assumptions are intertwined but they are also used all together. This situation occurs, because human organism is a one strictly linked biological system, what means that it is very difficult to separate some of its structures or functions, without a loss of understanding how it works as a one integrated entity.

It also worth emphasising that, human body consists of 16 elements. The adult body has in its composition 65% of Oxygen, 18% of Carbon, 10% of Hydrogen, 3% of Nitrogen, around 2% of Calcium, around 1% of Phosphor and trace amounts of other elements[5]. The presented above body composition is responsible for the nutritional conditions and needs, what in consequence influence on specified body build.

For many targets: anthropological, health etc. is a need to use sorted body-build types systematics[6,7]. Over recent years, many methods for the evaluation of the somatic structure types has been created, such as: Perkal's environmental indexes method, body type according to typological system of Kretschmer, Wanky, Scheldon, Heath-Carter method etc. The last mentioned method is based on traditional conception evaluation of three body components which illustrate: fatness (endomorphy), massiveness (mesomorphy) and body slimness (ectomorphy). This

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method was initiated by Sheldon and extended as well as improved be Barbara Heath and Lindsay Carter[8,9].

The aim of this research is to determine body types for selected female students of first year studies Kazimierz Wielki University, according to Barbara Heath and Lindsay Carter method.

Materials and Methods

The basic anthropometric measurements were taken, during the summer training camp for Kazimierz Wielki University students, in Chmiąża Szlachecka, in Kuyavian-Pomerania Voivodeship. The aim of the annual summer camp for students, is to show and teach different forms, ideas and possibilities to perform classes of Physical Education and other sport activities on the ground, from normal runs and open air plays to activities with bicycles, rollers and poles. Also the different landforms play role in this project, such as: forests, hills and valleys, water areas for swimming and sailing.

The anthropometric measurements were taken on 13th of July in the afternoon hours, at the break of classes. Twenty-three women in the age of 20–24 participated the research. The investigated students had sportswear (shirt and shorts). The follows measurements were performed: body heath (B-V), body mass, triceps skinfold (TSF), subscapular skinfold (SCSF), suprailiac skinfold (SISF), elbow weidth (cl-cm), knee width (epl-epm), circumference of the arm, leg, waist and hips. From received values calculated as follows: fat content, Rohrer slimness index, Body Mass Index, [kg/m^2], Wist to Hip Ratio Index (WHR), Arm Muscle Circumference (AMC) and body construction components: fitness (endomorphy), body massivness (mezomorphy), and body slimness (ectomorphy). All measurements have been done by using Swiss anthropometric tools, from Siber Hegner & Co. Ltd (Switzerland): anthropometer, outside caliper, vernier caliper, anthropometric tape, balance. All measurements were taken by the same investigator, applying standard anthropometric methods according to the procedure of the International Biological Programme. In accordance with adopted rules, every student was investigated in one go. For every participant, the separated protocol was prepared, where every single result has been saved, what finally gave the personal set of all results. After completion of the desired results, the values were precisely tabulated, what helped with basic statistical calculations afterwards, as well as to calculate regression (research results). Regression analysis is a method which is used to investigate and find the connection between received results and to predict next values of different parameters, based on predictions and conclusion obtained at the first step. For this purpose, the program named Statistica 12 has been used in this research.

Results

The analysis of the obtained results show, that average value for fat tissue content beside body mass, was 13,56%, however the parameters which characterize the somatotype, were lower than the average and had amounted respectively: endomorphy (body fatness)- 3,59, mesomorphy (body massiveness)- 3,52 and ectomorphy (body slimness)- 2,78.

The presented measurements show that tested body profiles may be classified as rather slim, low-fat and medium-strong body build (Table 1 and Figures 1, 2).

The results are cumulated in Table 1. The analysis of the results point out the average BMI value, which in tested group of female students, is 20,46. The proper body mass have 78%, whereas 22% are students are character-

TABLE 1
NUMERICAL CHARACTERISTICS OF INVESTIGATED STUDENTS

Tested features	Averages	Minimum	Maximum	s	v
Body height	165,8174	152,5000	179,0000	6,521270	3,93280
Body mass	58,5609	48,1000	73,9000	7,240840	12,36464
Fat tissue (%)	14,0970	12,2800	18,1700	1,294553	9,18321
Rohrer Index	1,2839	1,0800	1,5200	0,124160	9,67047
BMI	21,2604	18,5000	25,5700	1,933027	9,09214
WHR	0,8078	0,7600	0,8900	0,031328	3,87802
AMC	22,1296	18,2300	27,7700	2,246058	10,14958
Endomorphy	3,5870	3,0000	5,0000	0,468367	13,05750
Mezomorphy	3,5217	2,0000	5,0000	0,897956	25,49750
Ectomorphy	2,7826	1,0000	4,5000	0,986570	35,45486

(source: own materials)
BMI – Body Mass Index
WHR – Waist to Hip Ratio (ratio)
AMC – Arm Muscle Circumference-nutrition protein index
Wskaźnik Rohrera – the level of slimness

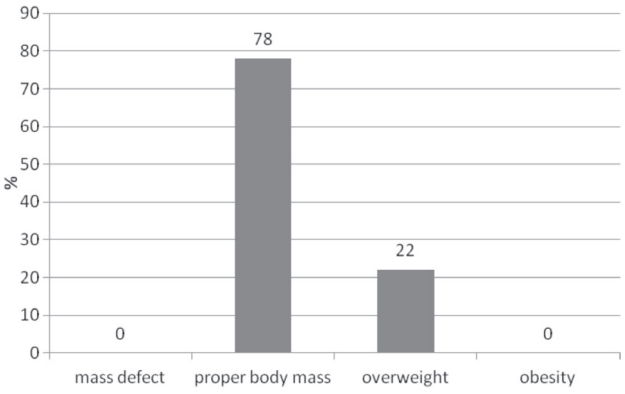

Fig 1. BMI values for researched students (source: own materials).

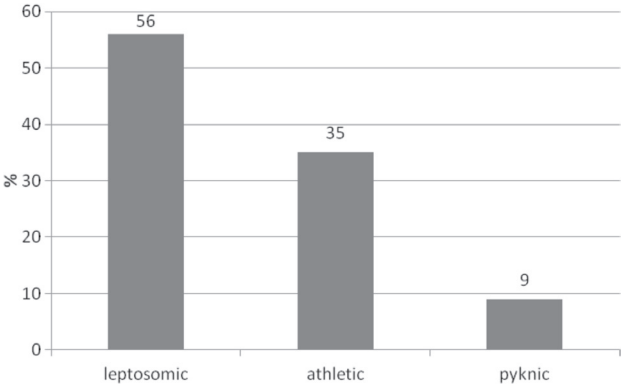

Fig 2. The degree of slimness of researched female students.

ized with overweight. For none of the participant mass defect or obesity has been noted (Fig 1).

Using the Kretschmer's constitutional classification system of body-types, Rohrer index and Curtius key, the calculated body slimness for research participants was 1,28. In that group was 13 (56%) leptosomic bodies,8 (35%) athletic and 2 (9%) pyknic types (Tab 1, Fig 2). (Figures 3 and 4, Table 2)

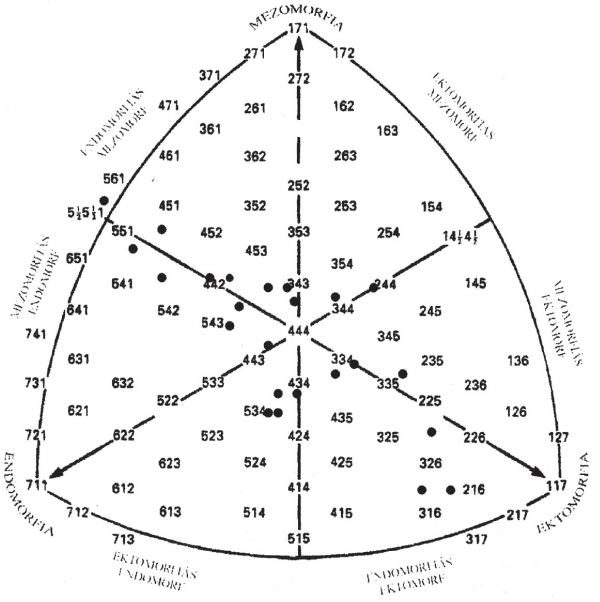

Fig 3. Sheldon somatogram adapted to Heath-Carter Method, with marked points that corresponds to research students (source: own materials).

TABLE 2
REGRESSION FOR ENDOMORPHY, MEZOMORPHY, ECTOMORPHY AND OTHER PARAMETERS

	Multiple regression results:					
	Dep.Var.Zmn8	Multipl. Regr. R =,90860267		F = 10,14127		
		R^2=,82555882		df = 7,15		
	Particip. 23	Corr. R^2=,74415294		p =,000105		
	Estimation standard error:,236906212					
	Absolute term –4,563129352	St.Err.: 22,76297		t(15) = –,2005	p =,8438	
	Var 1 b*=,533	Var 2 b*=–2,3		Var3 b*=,657		
	Var 4 b*=–2,4	Var 5 b*=4,65		Var6 b*=–,29		
	b*	St. Err. of b*	b	St. Er. of z b	T (14)	p
			–4,56313	22,76297	–0,20046	0,843811
Body height	0,53332	1,955098	0,03830	0,14042	0,27278	0,788740
Body mass	–2,28646	3,361713	–0,14790	0,21745	–0,68015	0,506773
Fat tissue (%)	0,65672	0,222973	0,23760	0,08067	2,94528	0,010029
Rohrer Index	–2,43560	2,818422	–9,18777	10,63186	–0,86417	0,401101
BMI	4,65344	4,385658	1,12759	1,06271	1,06106	0,305450
WHR	–0,28535	0,216834	–4,25947	3,23672	–1,31598	0,207938
AMC	–0,35230	0,195872	–0,07346	0,04084	–1,79863	0,092228

b– the model parametr (regression index) describing the influence of variable value

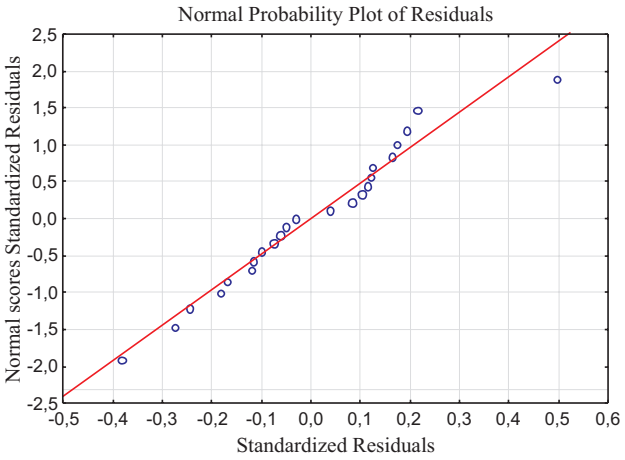

Fig. 4 Graphic model of line regression for endomorphy, mezomorphy, ectomorphy and other parameters, including the analysis of the Residuals.

From the analysis of the graphic model of multiple line regression, it can be deducted that 74,4% of variable values: endomorphy, mezomorphy, ectomorphy are explained by the other variables. The R^2 value is the quality i ndex of matching the model to data. R^2 nearly reaching 1,0 indicates that almost all dependent variables may be explained by independent variables, included to the model.

In this analysis the main independent variable is fat tissue (%) with statistical significance p=0,000105. For 25,6% the rest of independent variables, show no statistical significance. In this case, the conclusion is that during the determination of the morphological type in accordance with Sheldon typology, there is enough to measure fat tissue in % (Tab 2, Fig 2).

The group of researchers has gone into the content of influence the factors (independent) to different body build types by considering endomorphy, mezomorphy and ectomorphy separately and independently.

It was noted, that for endomorph types it is impossible to build statistical significance model of line regression, because there is no statistical significance of separated independent variables, although correlation index show some relations which have status of statistical significance (Table 3).

Due to lack of statistical significance of regression model for different variables, the graphic model of regression is not illustrated.

According to the Fig 5 it is easy to see, that 71,0% of variables for mezomorphs is explained by quality matching index. In discussed analysis main independent variable is WHR with statistical significance p=0,000252. Rest of independent variables present no statistical significance. One can deduce that, to determine mesomorphic type, there is only need to evaluate WHR in % (Tab 4, Fig 5).

Where:

The model of multiple line regression for ectomorphs shows Table 5. According to that table, it can be noted that 74,4% (corrected R^2) of variables for ectomorphs is explained by quality matching index.

The main independent variable is fat tissue with statistical significance p=0,000105. Rest of independent variables present no statistical significance. It can be concluded that to determine ectomorphic type there is a need only to evaluate fat tissue in % (Tab 5, Fig 6).

TABLE 3
REGRESSION FOR ENDOMORPHY AND OTHER FEATURES

	Multiple regression results:					
	Dep.Var.Zmn10	Multipl. Regr. R =,98058713		F = 53,58978		
		R^2=,96155112		df = 7,15		
	Particip. 23	Corr. R^2=,94360831		p =,000000		
	Estimation standard error:,234280101					
	Absolute term –2,924586235	St.Err.: 22,51064		t(15) = –,1299	p =,8984	
	Var 1 b*=,582	Var 2 b*=–,72		Var3 b*=,042		
	Var 4 b*=–,70	Var 5 b*=,196		Var6 b*=,036	Var b*=,053	
	b*	St. Err. of b*	b	St. Err. of b	T (14)	p
			–2,92459	22,51064	–0,129920	0,898356
Body height	0,581983	0,917880	0,08805	0,13886	0,634052	0,535597
Body mass	–0,716609	1,578258	–0,09764	0,21504	–0,454051	0,656293
Fat tissue (%)	0,041617	0,104681	0,03172	0,07978	0,397556	0,696558
Rohrer Index	–0,703966	1,323193	–5,59366	10,51400	–0,532020	0,602503
BMI	0,195688	2,058980	0,09988	1,05093	0,095041	0,925540
WHR	0,036242	0,101799	1,13956	3,20084	0,356019	0,726784
AMC	0,053067	0,091958	0,02331	0,04039	0,577073	0,572450

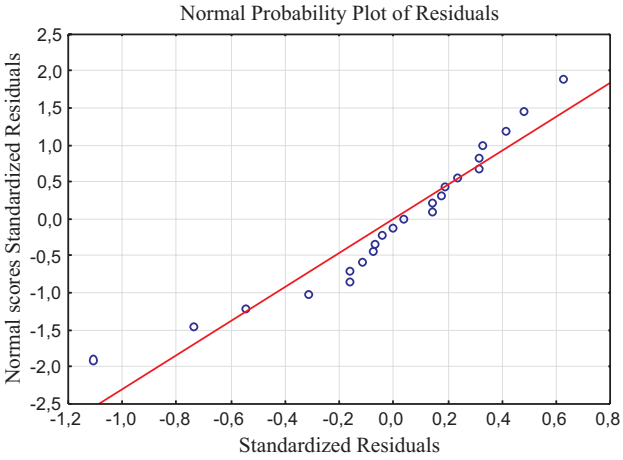

Fig. 5 Graphic model of line regression for mezomorphy and other features, including the analysis of the Residuals.

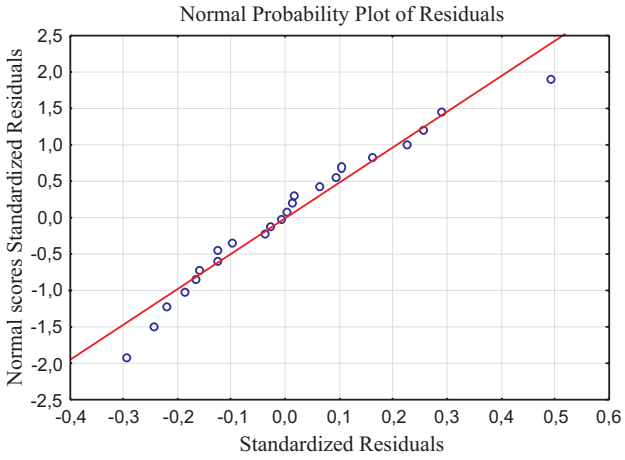

Fig. 6 Graphic model of line regression for ectomorphy and other features, including the analysis of the Residuals.

TABLE 4
REGRESSION FOR MEZOMORPHY AND OTHER FEATURES

	Multiple regression results:					
	Dep.Var.Zmn9	Multipl. Regr. R =,89580854		F = 8,705566		
		R^2=,80247294		df = 7,15		
	Particip. 23	Corr. R^2=,71029365		p =,000252		
	Estimation standard error:,483318956					
	Absolute term –5,041533563		St.Err.: 46,43936	t(15) = –,1086	p =,9150	
	Var 1 b*=,405	Var 2 b*=2,13		Var3 b*=–,09		
	Var 4 b*=4,51	Var 5 b*=–4,5		Var6 b*=–,59	Var 7 b*=,158	
	b*	St. Err. of b*	b	St. Err. of b	T (14)	p
			–5,0415	46,43936	–0,10856	0,914989
Body height	0,40535	2,080450	0,0558	0,28647	0,19484	0,848135
Body mass	2,13244	3,577251	0,2645	0,44362	0,59611	0,559989
Fat tissue (%)	–0,09349	0,237269	–0,0648	0,16458	–0,39401	0,699121
Rohrer Index	4,50979	2,999127	32,6158	21,69034	1,50370	0,153420
BMI	–4,53952	4,666847	–2,1089	2,16806	–0,97272	0,346120
WHR	–0,59259	0,230736	–16,9590	6,60332	–2,56826	0,021408
AMC	0,15841	0,208431	0,0633	0,08333	0,75999	0,459039

Discussion

The similarity of body build in artistic gymnasts group was presented by polish researchers Poliszczuk and Broda[11]. They used Heath-Carter method, mainly based on classic conception of three components of Sheldon's body-build. They claimed that the similarity increases together with professional sport level as well as body-build helps, not only with sport achievements, but also could be a factor which can prevent of unwanted injuries at the same time. The ability to keep a body balance according to somatic body type is a basic criterion during the pre-selection to this sport discipline. The research was carried out on 19 artistic gymnast girls that were in the age of 8–11. To judge the level of body-balance, the posturography technique was used.

The average of I component of endomorphy for gymnasts was 2,65±1,29, II component of mezomorphy – 2,45±0,37 and III component of ectomorphy – 3,95±0,64. The average of body mass index (BMI) in that group reached 15, 32, what indicates to advanced body slimness.

It was also observed that body type for gymnasts is mostly characterized by the advantage of ectomorphy element. The research shows, that gymnasts bodies are very slim and slender.

Krakowiak at al.[12] observed, that discussed sport discipline requires specific predispositions in a range of body

TABLE 5
REGRESSION FOR ECTOMORPHY AND OTHER PARAMETERS

	Multiple regression results:					
	Dep.Var.Zmn8	Multipl. Regr. R =,90860267		F = 10,14127		
		R^2=,82555882		df = 7,15		
	Particip. 23	Corr. R^2=,74415294		p =,000105		
	Estimation standard error:,236906212					
	Absolute term –4,563129352		St.Err.: 22,76297	t(15) = –,2005	p =,8438	
	Var 1 b*=,533	Var 2 b*=–2,3		Var3 b*=,657		
	Var 4 b*=–2,4	Var 5 b*=4,65		Var6 b*=–,29	Var 7 b*=–,35	
	b*	St. Err. of b*	b	St. Err. of b	T (14)	p
			–4,56313	22,76297	–0,20046	0,843811
Body height	0,53332	1,955098	0,03830	0,14042	0,27278	0,788740
Body mass	–2,28646	3,361713	–0,14790	0,21745	–0,68015	0,506773
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AMC	–0,35230	0,195872	–0,07346	0,04084	–1,79863	0,092228

(source: own materials)

build and composition. The research was performed on 21 male runners for distances 100 and 200m (13 participants from Bydgoszcz's clubs and 8 from National team), all in the age 17–21. They determined runners body type and composition of different sort categories and evaluate the differences in body types between athletes from National team and from sport clubs in Bydgoszcz. The somatotype of investigated runners was determined in accordance with Sheldon somatogram included the modifications from Heath-Carter method. The body compositions were measured by a Segmental Bioelectrical Impedance Analysis (SBIA). It was concluded that both groups of athletes are characterized by very similar parameters like body height, body mass and other weight-height indexes. The common somatotype for athletes from National team was created as 2,6-4,0-2,7. For group of sprinters from Bydgoszcz these values were respectively 2,1-4,0-2,7. The investigated sprinters had also similar body compositions. In the body build in both group mesomorphic type was dominant. Sportsmen from National team had also higher value of endomorphic element.

Poliszczuk and Mosakowska[13] had started the research on badminton players, the representative of National team, that were in the age of 19–26. The aim of this study was the morphologic characteristic and body type model determination, for professional badminton representatives. 9 of the top-ranked polish players participated the research. For evaluations, Sheldon somatogram was used with modifications from Heath-Carter method. To receive body compositions parameters, the method using special body composition analyzer Tanita BC- 418, was applied.

The obtained results show that polish badminton player are definitely characterized by tallness (H) 184,63±6,01 cm, proportional to it mass (M) 80,71±9,05 kg and weight-height index (BMI) 23,60±1,96 kg/m^2. They have also low percentage of fat tissue, which is around 9,6% of total body mass.

The aim of Čabrić AT All.[14] research was to investigate the body musculature between both: male and female tested groups.

695 students participated the research. Somatotypes were determined according to Sheldon typology and body composition by applying SBIA method. Male and female students of Physical Education had much higher results of investigated body musculature in comparison to their peers from Collegium Medicum. It was noted, that increased physical activity contributes to higher protein body-weight, total amount of liquids and slim figure (LBM).

Students from different backgrounds are subjects of many researches, also anthropometric. The differentiation in a view of Kretschmer typology was investigated by Szafraniec[15]. She considered the group of female students from Natural Science at Rzeszów University. She tested the influence of living environment and conditions to a somatic body build. 143 anthropometric measurements were performed on random female students of Natural Science, from Biology and Agricultural Division, at Rzeszów University. Most of the students were characterized by leptosomic body type. Moreover, students from villages had wider shoulders, larger chest circumference and were significantly heavier than students from big cities. No correlation between living conditions and menarche time was noted. It was found that students investigated from 2009/2010 academic years had stronger body build than their peers from 1999/2000.

In the research carried out by Steinfeldt, Carter, Benton, Steinfeldt [16] significantly higher results of musculature was noted for student athletes than for students that did not practice any sport. It was also observed that only part of the group of researched students accepted their condition of musculature. 45% admitted they accepted said musculature only in a view of sport they practice, 42% due to their health, but 16% did not accept their musculature condition.

The next research carried out by Genovese and Little[17], where participated 30 women and 24 men, an important correlation between mesomorphic body-build and some status of personality was found, which in psychology is known as »Experimental cognitive style«. Significant relations was also discovered between mesomorphic somatotype and »experimental cognitive style« for men (r = 0,33) and for women (r = 0,25). Men representing said style, a substantial correlation occurred only in a case of endomorphic (r=0,39) and ectomorphic build (r= –0,48).

Russian scientists Filippova, Rubanovich, Aizman[18] investigated the group of girls in the age of 9–22 and found, that professional aerobic have important influence to circulatory and musculature systems and less to morphological body properties. Investigated girls in a substantial part represented mesomorphic body type.

Other authors Martínez and López[19] researched 18 women, on average in the age of 66 ± 4,7, where one part of this group had metabolic syndrome (8 women) (abdominal (central) obesity (cf. TOFI), elevated blood pressure, elevated fasting plasma glucose, low high-density lipoprotein (HDL) levels). Second part of investigated group (10 women) did not have said syndrome. After taking all wanted anthropometric measurements and necessary calculations to determine kind of somatotype, it was observed that somatic characteristic in both group was similar. Mezomorphic type including some endomorphic elements dominated, in accordance with Heath-Carter method. Dynamic balance was evaluated using the test know as Up and Go. The received results from said test showed, that women with metabolic syndrome had worse dynamic balance than women from another group.

Korean researchers Noh, Kim and Kim[20] empirically proved, using Sheldon typology in a modification of Heath-Carter, the difference in morphologic body build evaluated for leading national wrestlers (32 men) and evaluated for men being sport inactive (15 men). Both group of research participants were in a comparable age. In a group of sportsmen, 30 men were classified as ones had mezomorphic body type, 2 men from said group were noted as had endomorphic body build. In the group of sport inactive men, the classifications were as follows: 2 persons- endomorphic build, 3 persons- mesomorphic, 5 persons- ectomorphic type and 5 men represented the so-called centermode (which groups all characteristics on a similar degree). Moreover, in both groups higher body mass was posively correlated to Body Mass Index (BMI) as well as to mezo- and endomorphic components, however negatively correlated to ectomorphic component.

Another author Yavuz[21] tried to determine the desired somatic features for aspiring girls volleyball players (in the age of 14), for which the measure of success was a participation in a national championships. The research carried out on 60 girls showed, that besides having basic best features and properties for this sport discipline, such as increased length of the upper and lower limbs, it is also necessary to have low amount of fat tissue as well as ectomorphic body type as dominant.

Some scientists Carlin, Trent, Craig[22] said, that less risk of eating disorders for sportsmen may occur, while more aware of this problem are people who are threatened this issue.

Carter-Francique[23] indicates the correlation between obesity and physical activity for black students from United States.

It is worth emphasizing the usefulness of Sheldon method improved by Barbara Heath and Lindsay Carter. Mentioned authors used said method to evaluate human body types, for different groups of people. However, the problem is still open to discuss and investigate and need further research.

Conclusions

1. The proper body mass had 78% of investigated students, 22% of them were overweight.
2. The average content of fat tissue, in the presence of body mass, was 13,56%.
3. The parameters characterizing the somatotype, were much under the averages: endomorphy – 3,59, mezomorphy– 3,52 and ectomorphy – 2,78.
4. Investigated figures were classified as medium-slim, low-fat and medium-strong structure.
5. The research participants presented: leptosomatic type in 56%, athletic type in 35% and picnic type in 9%.
6. For endomorphic body type it is not possible to build model of line regression, which is statistical significant; to determine mezomorphic type it is enough to evaluate WHR parameter in % and to determine ectomorphic type- fat tissue (%).

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OCJENA IZGLEDA KOD STUDENTICA U SKLADU S METODOM HEATH-CARTER

S A Ž E T A K

Svrha – Cilj ovog istraživanja je utvrditi osnovne morfološke parametre sastava tkiva, s posebnim naglaskom na procjenu tjelesne vrste, prema Barbara Heath i Lindsay Carterovoj metodi. Metode – Osnovna antropometrijska mjerenja provedena su u lipnju 2016., tijekom ljetnog trening kampa za studente Sveučilišta Kazimierz Wielki. Studija obuhvaća samo mjerenja na studentima, od prve godine studija, tečajeva tjelesnog odgoja. Za mjerenja su korišteni švicarski antropometrijski alati, od Siber Hegner & Co. Ltd (Švicarska). Sva mjerenja je poduzeta od strane istog istražitelja primjenom standardnih antropometrijskih metoda prema postupku Međunarodnog Biološkog Programa. Rezultati – Analiza rezultata pokazuje da je prosječni sadržaj masnog tkiva prema tjelesnoj masi između ispitanih žena bio 14,097%, međutim, parametri koji karakteriziraju somatotip su niži od prosječnih vrijednosti i iznosili su: endomorfija (mjerenje masti): 3,59, mezomorfija (mjerenje masivnosti tijela): 3,52 i ektomorfija (mjerenje tjelesne težine): 2,78. Zaključci – Prikazana mjerenja pokazuju da su ispitivana tijela bila u skupini srednje tankog, srednje niske masnoće i srednje jake tjelesne masivnosti.