Influence of the somatotype on intake of energy and nutrients in women

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Abstract

Nutrition is an integral part of the formation of fat and muscle and affects anthropometric parameters. Measurement of growth and weight gain can be used to characterise the physical development of human beings. Weight-to-height parameters can be used to determine body types (somatotypes). Somatotypes have recently been studied due to their link to various diseases, including diet-related ones. The study involved 154 female students of a university in of Warsaw, aged 21-25 years. The study was based on a questionnaire composed of two parts. The first contained information on weight, height, place of residence, supplementation, self-health assessment, and physical activity. The second part was based on three-day dietary food records. The subjects were divided into three groups according to somatotypes: ectomorphic, mesomorphic and endomorphic. The women of the ectomorphic somatotype consumed the greatest amount of energy, protein, fats, vitamins B_1, B_6, copper, and retinol. The women of the mesomorphic somatotype consumed more carbohydrates than women of other body types did. Endomorphic women had great difficulty in maintaining ideal body weight, even though the food they consumed supplied the least amount of energy, macronutrients, and selected vitamins and minerals. Somatotype, that is the type of human physique, affects the consumption of energy and some nutrients (protein, fat, vitamins B_1 and B_6, copper and retinol).

KEYWORDS: somatotype, body composition, nutritional intake, energy, nutrients

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Introduction

Somatotype is a unique way of describing the human physique. Sheldon's three somatotypes are commonly used: ectomorphic, mesomorphic and endomorphic, differentiated by size and body composition (Carter & Heat 1990). This classification is based on the genetic determination of the level of tissue development. Generally, in the endomorphic physique, the prevailing component is fat, in the mesomorphic muscle and in the ectomorphic bone (Malinowski & Strzałko 1997; Fett et al. 2006). The endomorphic somatotype is characterised by a high proportion of epithelial tissue, fat, and internal organs, as well as the predominance of the transverse dimensions over the longitudinal ones, stocky physique, small skeleton, poorly developed muscle tissue and a tendency to accumulate fat. The mesomorphic physique can be characterized by strongly developed bone and muscle tissue, wide neck and face, well-developed chest, wide shoulders, hands and feet, narrow pelvis, and long upper and lower limbs. Ectomorphic physique can be defined by the prevalence of nervous and bone tissue as well as a narrow and slim body, low body weight, and the predominance of the longitudinal dimensions over the transverse ones and a long neck and face (Singh & Mehta 2009).

Apart from genetics, nutrition is an integral part in the creation of fat and muscle and affects anthropometric parameters (Wolański 2012; Raschka & Graczyk 2013). Height and weight are the basic indicators of the physical development of human body and are presented in the correct ratio based on mathematical formulas. The height-to-weight ratio is also used to determine body types or somatotypes (Rafter 2007; Maddan 2008). According to Sheldon somatotype is constant throughout one's life, but body size and appearance change (Malinowski & Strzałko 1985). Currently, Sheldon's typology is widely used and has also been developed and perfected by Carter and Heath (1990).

Because the individual somatotypes show clear differences in fat and muscle content, it must be assumed that people with different body types require different dietary treatments. This study has been undertaken in order to partially explain the above-mentioned relationship.

Study design and participants

The study was conducted on 154 female university students. The subjects were chosen from the group of healthy women aged 21-25, with no chronic diseases, not pregnant or lactating, and not using weight-reducing diets.

Dietary assessment

In the study, a questionnaire was used to assess dietary habits. There were questions about age, weight, and height. Data on food consumption was collected using three-day dietary food records from two weekdays and one weekend day. The subjects had to list meals, food products, beverages and give portion sizes. Mean energy intake and macronutrients (i.e. proteins, fats, cholesterol, carbohydrates, fibre, vitamins, and minerals) were estimated using a computer program called Energia, taking into account and unavoidable variation of 10% (Turlejska et al. 2004). The correctness of energy supply and selected components of the diet was compared with the relevant standards (Jarosz 2012). The results were expressed as the percentage of people whose consumption was not covered in demand for selected components (cut-off point).

Anthropometric assessment

Women were classified to a certain somatotype on the basis of the Rohrer Index (RI) = body weight (g) / height (cm^3) x 100, which was described by the Curtius key (Dix et al. 2013; Pezala & Zukow 2013): ectomorphic type RI <1.28; mesomorphic type RI = 1.29-1.46 and endomorphic type RI > 1.47 (Sterkowicz-Przybycień & Żarów 2005). In the studied group, 52 subjects were classified as being ectomorphic, 51 as mesomorphic and 51 as endomorphic.

The body mass index of each subject was calculated using their weight and height (kg/m^2). According to WHO guidelines, each student was classified to one of the categories: below 18.5: underweight; 18.5-24.9: normal weight; 25.0-29.9: overweight; 30.0-34.9: first-degree obesity; 35.0-39.9: second-degree obesity and above 40: third-degree obesity (WHO 2004).

To assess the level of energy requirements, a basal metabolic rate according to Harris-Benedict equation was calculated, and then physical activity level (PAL) was assigned to each subject.

Statistical analysis

The values of the consumption of energy, macronutrients, vitamins, and minerals were expressed as means with standard deviation, demonstrating the inter-individual variability, median, minimum and maximum values. Nutrient density was presented as a mean with standard deviation. Having established that the vast majority of the variables for each somatotype had a normal distribution (Shapiro-Wilk test, $p > .05$), the results were subjected to analysis of variance with a post hoc Tukey test. The Pearson correlation coefficient between the Rohrer Index and some variables has been defined for these variables whose values differed significantly between somatotypes. In the analysis, statistically significant results had $p \leq .05$

Results

The study involved 154 female students of a university in Warsaw, at the age of 21-25. More than half of the subjects lived in the family homes (53%) did not use dietary supplements (67%) and assessed their health as good (68%), and physical activity as the average (53%).

The average values of Rohrer Index (RI) were as follows: 1.62 ± 0.19 for endomorphic somatotype, 1.16 ± 0.07 for ectomorphic somatotype and 1.36 ± 0.05 for mesomorphic somatotype ($p \leq 0.05$).

The subjects with endomorphic physique had average BMI of 26.8 ± 3.26, those with ectomorphic physique 19.6 ± 1.42 and subjects with mesomorphic physique 22.4 ± 1.11 ($p \leq 0.05$).

Each student was assigned to the appropriate BMI category, according to the WHO guidelines. The subjects with a mesomorphic somatotype were characterized by a normal body weight for the entire group (n = 51). Among the subjects with ectomorphic physiques, 77% of subjects had normal body weight, and 23% of them were underweight. Among the subjects with endomorphic physiques, 55% were overweight, 29% had normal body weight, and 16% had first or second-degree obesity.

According to the energy supply in the diet, the ectomorphic subjects showed the highest values and mesomorphic women showed slightly lower values. The lowest mean energy intake was found in the endomorphic group (Table 1). The difference between the endomorphic group and the other two was statistically significant, which was not found in the case of the difference between ecto- and mesomorphic groups ($p < 0.05$). It has been shown that the whole study group did not meet the recommended daily energy requirement according to the Harris-Benedict equation and physical activity level (PAL).

Average protein intake among the three somatotypes was at a similar level (Table 1). The highest value was found in the diets of ectomorphic subjects, while the lowest in endomorphic ones. The ratio of animal to plant protein in each study group was 2:1, which does not meet the dietary recommendations (Jarosz 2012) according to which the ratio should be 1: 1. The highest intake of animal protein was found in the ectomorphic subjects.

In the diet of ectomorphic women, fat constituted a significantly higher portion than in the diet of the endomorphic ones (Table 1). The subjects with endomorphic physiques consumed the least amount of fat in a daily ration. It has been shown that 43% of endomorphic subjects, 21% of ectomorphic and 22% of mesomorphic ones had not met daily requirements for fat consumption. The daily food rations of ectomorphic and endomorphic subjects demonstrated a statistically significant difference in the intake of saturated fatty acids. The mean cholesterol consumption was at similar levels for all three somatotypes (Table 1).

The lowest carbohydrate intake was found among the endomorphic women in comparison to the other groups. The highest intake of dietary fibre was found in the group of ectomorphic women (Table 1). However, there was no statistically significant difference in dietary fibre consumption between the three subject groups. Average sucrose consumption was the highest for the ectomorphic type, lower for the mesomorphic one, and the lowest for endomorphic one (Table 1). There were no statistically significant differences in sugar consumption between the three groups.

Table 1: Mean daily intake of energy and selected macronutrients in women of various somatotypes

Nutrient	Endomorphic type Mean Median Min-max	Endomorphic type Cut-off point*	Ectomorphic type Mean Median Min-max	Ectomorphic type Cut-off point*	Mesomorphic type Mean Median Min-max	Mesomorphic type Cut-off point*
Energy (kcal)	1397a±304 1366 869-2271	100	1592b±442 1547 925-3167	94	1577b±309 1554 946-2367	96
Protein (g)	61.3±12.6 59.7 37.1-91.7	23	66.1±17.8 63.3 37.8-120	4	64.2±16.0 60.1 35.7-125.9	6
Protein (g/kgbm)	0.84±0.19a 0.82 0.51-1.61	0	1.20±0.34b 1.11 0.59-2.19	0	1.06±0.27c 0.99 0.64-1.91	0
animal (g)	43.1±12.8 42.3 21.8-77.8	96	44.9±13.6 45.8 18.9-76.9	89	43.8±15.3 39.9 18.2-113	94
plant (g)	18.2±5.01 17.9 9.4-30.4		20.1±8.00 17.6 8.91-49.7		20.4±4.39 20.5 10.4-28.8	
Fat (g)	48.9a±17.6 45.8 21.4-93.5	43	56.3b±16.6 53.4 20.9-102	21	56.1b±16.6 55.5 27.6-101	22
SFA (g)	18.5a±7.00 17.8 7.34-47.31	no norm	22.3b±8.31 22.2 7.47-58.6	no norm	21.1ab±8.11 21.2 0.17-40.8	no norm
MUFA (g)	18.8±8.19 17.1 6.43-43.5	no norm	22.2±8.98 20.6 8.17-63.4	no norm	21.1±7.25 20.6 8.56-41.6	no norm
PUFA (g)	7.72±3.19 7.51 2.39-16.8	no norm	9.29±5.30 8.47 2.73-35.1	no norm	9.51±5.25 8.19 4.84-36.7	no norm
Cholesterol (mg)	213.4±109 177 74.7-541	no norm	254.9±110 231 85.4-572	no norm	228±86 209 97.7-427.7	no norm
Carbohydrates (g)	176.1a±43.8 175 82.3-299	16	201.3b±60.2 193 97.3-362	13	203.7b±43.7 201 98.3-282	3
Fibre (g)	15.9±5.27 15.3 7.00-26.9	94	18.1±9.46 15.7 8.18-69.8	90	16.7±5.40 15.6 4.69-29.4	92
Sucrose (g)	34.4±18.5 33.1 11.9-101	49	41.3±19.8 37.5 9.5-92.4	52	39.8±19.7 37.2 8.58-100	49
Energy from protein (%)	18.2±4.59 17.2 10.2-35.0	50	16.9±3.33 16.7 11.1-28.6	67	16.5±3.63 15.8 12.2-30.4	52
Energy from fat (%)	31.1±6.46 30.7 19.4-49.6	18	32.7±5.96 32.4 18.7-47.4	28	31.7±5.62 32.4 18.4-45.0	23
Energy from carbohydrates (%)	50.8±6.90 50.7 35.6-65.8	41	50.4±6.52 50.4 36.8-65.4	46	51.8±5.92 51.4 35.4-62.5	23

* Subjects who do not meet the standards (%), according to Jarosz (2012); a,b,c – values marked with the different characters differ significantly, p ≤ .05; values marked with the same character do not differ significantly, p>0.05; post hoc Tukey test; SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids

In each subject group energy supply from macronutrients was at similar levels (Table 1). The highest percentage of subjects who did not meet the recommended requirements came from the ectomorphic group, followed by the mesomorphic, and finally the endomorphic group.

Table 2: Mean daily intake of selected vitamins in women of various somatotypes

Vitamins	Endomorphic type Mean Median Min-max	Endomorphic type Cut-off point*	Ectomorphic type Mean Median Min-max	Ectomorphic type Cut-off point*	Mesomorphic type Mean Median Min-max	Mesomorphic type Cut-off point*
B1 (mg)	0.79a±0.27 0.72 0.41-2.18	67	0.93bc±0.35 0.85 0.46-2.07	67	0.87c±0.30 8.65 0.37-1.91	57
B2 (mg)	1.29±0.33 1.22 0.75-2.27	4	1.44±0.44 1.37 0.72-2.86	15	1.30±0.44 1.22 0.63-3.42	8
B6 (mg)	1.44a±0.39 1.42 0.70-2.65	14	1.69bc ±0.56 1.66 0.80-3.43	15	1.59c±0.45 1.55 0.85-2.85	8
B12 (mg)		10		21		18
Folate (µg)	171.2±72.4 162 77.5-519	98	178±108 153 71.3-794	100	167±49.9 165 81.2-284	94
C (mg)	57.0±35.5 50.4 9.94-152	0	63.7±40.1 59.3 4.29-261	0	67.8±42.6 62.5 3.65-186	0
PP (mg)	11.8±4.07 11.8 4.38-21.3	43	13.3±4.47 13.09 4.98-22.2	37	12.97±0.45 1.55 0.85-2.84	29
A (µg retinol eq)	792±535 636 206-2753	29	891±531 796 255-2607	21	776±396 690 224-2293	20
Retinol (µg)	256±126a 237 96.9-761	0	319±136bc 303 85.7-730	0	296±113c 314 78.6-608	0
B-carotene (µg)	3645±2850 3177 795-13741	0	3896±3231 2922 356-15710	0	3376±2578 2990 662-12952	0
E(mg)	7.89±3.31 6.85 2.65-18.1	59	8.45±3.18 8.15 3.50-17.7	46	8.98±3.40 8.65 4.82-19.1	45
D (µg)	2.43±2.09 1.70 0.36-8.70	100	2.73±2.71 1.91 0.58-14.3	100	2.46±2.12 1.78 0.47-12.77	94

*Subjects who do not meet the standards (%), according to Jarosz (2012); a,b,c – values marked with the different characters differ significantly, $p \leq .05$; values marked with the same character do not differ significantly, $p > .05$; post hoc Tukey test

Significantly lower intakes of vitamin B_1, B_6 and retinol (Table 2) and copper (Table 3) has been found in the endomorphic subject group compared to other types of physique.

Table 4 shows the average nutritional density of the subjects' food intake. Statistical analysis showed a significantly higher content of vitamin B_{12}, calcium, phosphorus and zinc per 1000 kcal/day in the food intake of endomorphic women compared to other subject groups. A higher content of vitamins B_2 and folates per 1000 kcal/day in the food intakes of endomorphic subjects have also been shown compared to other somatotypes.

Table 5 shows a statistically significant correlation between RI Index and energy and nutrient consumption by the subjects. The analysis showed a negative correlation between RI Index and energy, plant protein, fat, SFA (saturated fatty acid), total carbohydrates, dietary fibre, thiamine, vitamin B_6, iron, zinc, and copper in the diet. Moreover, there was a positive correlation found between the RI Index and vitamin B_{12} supply per 1000 kcal/day.

Table 3: Mean daily intake of selected minerals in women of various somatotypes

Minerals (mg)	Endomorphic type Mean Median Min-max	Endomorphic type Cut-off point*	Ectomorphic type Mean Median Min-max	Ectomorphic type Cut-off point	Mesomorphic type Mean Median Min-max	Mesomorphic type Cut-off point
Ca	657±266 596 283-1673	76	669±247 629 244-1257	37	629±225 633 194-1205	73
P	1063±213 1058 575-1595	2	1151±340 1078 640-2354	0	1079±316 1034 512-2594	4
Mg	235±63 234 129-382	63	259±102 226 125-681	56	229±71.7 218 113-488	69
Fe	7.87±2.39 7.50 3.73-14.8	55	8.67±2.73 7.90 4.50-16.1	54	8.52±1.84 8.54 4.01-13.5	41
Zn	7.55±2.01 7.51 4.09-13.6	41	8.13±2.14 7.73 4.40-14.1	27	7.54±1.82 7.31 3.93-13.7	31
Cu	0.86a±0.25 0.79 0.43-1.57	27	1.02bc±0.44 0.88 0.50-3.23	17	0.91c±0.34 0.85 0.37-2.82	18

* Subjects who do not meet the standards (%), according to Jarosz (2012); a,b,c – values marked with the different characters differ significantly, p ≤ .05; values marked with the same character do not differ significantly, p > .05; post hoc Tukey test

Table 4: Daily nutritional density of diets in women of various somatotypes

Nutrient	Endomorphic type	Ectomorphic type	Mesomorphic type
Macronutrient (g/1000 kcal)			
Total protein	45.3±11.5	42.3±8.35	41.2±9.09
Animal protein	32.2±12.1	29.3±9.57	28.1±9.38
Plant protein	13.1±2.63	12.6±3.08	13.06±2.37
Fat	34.3±6.88	36.1±6.49	35.3±6.25
Carbohydrates	126.5±18.3	126±16.3	129±14.8
Vitamins (mg/1000 kcal)			
Vitamin A (µg/1000 kcal)	585±370	553±307	497±267
Retinol (µg/1000 kcal)	182±70.9	203±85.1	188±66.6
B-carotene (µg/1000 kcal)	2786±1251	2295±1746	2216±1747
Vitamin D	1.77±1.54	1.72±1.60	1.53±1.14
Vitamin E	5.63±1.90	5.41±1.69	5.79±2.01
Vitamin B1	0.57±0.16	0.58±0.13	0.55±0.14
Vitamin B2	0.95±0.29	0.91±0.18	0.84±0.26
Vitamin PP	8.84±3.63	8.72±2.96	8.45±2.83
Vitamin B6	1.07±0.34	1.07±0.25	1.03±0.27
Folate	126±55.6	110±39.6	109±34.7
Vitamin B12	2.40±0.95a	2.08±0.95bc	1.98±0.89c
Vitamin C	43.4±28.3	40.8±20.1	45.5±27.7
Minerals (mg/1000 kcal)			
Ca	487±202a	423±126bc	390±129c
P	787±205a	734±147bc	696±187c
Fe	5.70±1.62	5.56±1.19	5.47±1.02
Zn	5.47±1.23a	5.25±0.98bc	4.86±0.99c
Cu	0.62±0.18	0.64±0.17	0.58±0.18

a,b,c – values marked with the different characters differ significantly, p ≤ .05; values marked with the same character do not differ significantly, p > .05; post hoc Tukey test

Table 5: Pearson correlation between RI and supply of energy and selected nutrients

Nutrients	Correlation coefficient; significance
Energy and macronutrients	
Energy	r= -0.188; p= 0.020
Plant protein	r=-0.159; p=0.049
Fat	r= -0.165; p= 0.040
SFA	r= -0.162; p= 0.044
Total carbohydrates	r= -0.192; p= 0.017
Dietary fibre	r= -0.170; p= 0.035
Vitamins	
Thiamine	r= -0.225; p= 0.005
Vitamin B6	r= -0.211; p= 0.009
Minerals	
Fe	r= -0.192; p= 0.017
Zn	r= -0.171; p= 0.034
Cu	r= -0.189; p= 0.019
Nutritional density	
Vitamin B12	r= 0.191; p= 0.019

Discussion

The results obtained in this study showed the effect of somatotype on the supply of energy, macronutrients, vitamins, and minerals. The physique associated with differences in body composition may determine the intake of energy and nutrients.

The ecto- and mesomorphic women had a normal BMI, which suggests a lack of a tendency accumulate body fat. Such a tendency was largely present in endomorphic women. The obtained BMI values did not overlap with the Rohrer Index (RI). Thus, BMI is widely used to determine overweight and obesity, but is not a universal formula to classify a person into a body type and can only be used to determine an excess of adipose tissue (Kaarma et al. 2008; Genovese 2009).

There has been an observed difference in energy intake between endomorphic subjects and the other body types, and also a relatively high percentage of overweight and obese women in this group. At the same time, endomorphic women consumed less energy than recommended. This may indicate a low energy demand in these group due to a lower quantity of metabolically active muscle tissue (Blundel et al. 2012). Such a relationship and a lower energy intake in endomorphic people were also observed by Bolonchuk et al. (2000), Padro et al. (2001), Raschka & Graczyk (2013), and Raschka and Aichele (2014). Peterson et al. (2012) showed significant differences in energy intake between young endomorphic and ectomorphic women. However, Bolonchuk et al. (2000) also observed a similar energy intake in endo- and ectomorphic men, which was lower than that of mesomorphic men. This study demonstrates the similarity between ecto- and mesomorphic women in this regard. Therefore, it can be assumed that the effect of somatotype on energy intake depends on gender. Endomorphic people, who tend to accumulate body fat, may intentionally restrict energy intake, particularly from fats and carbohydrates in order to inhibit weight gain. However, there is an increased nutritional density of certain nutrients in their diet, which should be regarded as a positive phenomenon.

Raschka and Aichele (2014) and Peterson et al. (2012) observed that endomorphic women showed the lowest protein intake per kilogram of body mass. Additionally, it has been concluded that it was due to lower plant protein intake.

In this study, there was no statistical difference observed in the consumption of cholesterol between three somatotypes. Chrzanowska et al. (2006) showed associations between physique and lipid profile in women. They showed that somatotype components had a weaker influence on serum lipid variability – the direct influence being about 10%. The HDL level was positively correlated with ectomorphy and negatively with endomorphy. The other lipids, particularly TG, correlated inversely.

In this study, for the first time, an analysis of the relationship between somatotype and the consumption of micronutrients has been conducted. It has been shown that endomorphic women may have the worst nutritional status of thiamine, pyridoxine, retinol and copper as compared to other body types. This phenomenon requires a thorough analysis.

Conclusions

Somatotype (i.e. the type of human body physique) affects the intake of energy and some macro- and micronutrients in the diet. To explore these observations, further studies are required with the use of more specific methods.

Conflict of interest

None of the authors have any potential conflicts of interest to declare.

References

Blundell, John E., Philipa Caudwell, Catherine Gibbons, Mark Hopkins, Erik Näslund, Neil A. King & Graham Finlayson. 2012. Body composition and appetite: Fat-free mass (but not fat mass or BMI) is positively associated with self-determined meal size and daily energy intake in humans. *British Journal of Nutrition* 107(3): 445–9.

Bolonchuk, William W., William A. Siders, Glenn I. Lykken & Henry C. Lukaski. 2000. Association of dominant somatotype of men with body structure, function during exercise, and nutritional assesment. *American Journal of Human Biology* 12(2): 167–80.

Carter, Lindsay J.E & Barbara H. Heath. 1990. *Somatotyping – Development and Applications*. Cambridge, Cambridge University Press.

Chrzanowska, Maria, Jan Sobiecki, Małgorzata Kowal, Tomasz Kościuk & Stanisław Matusik. 2006. Is there a relationship between body build and the serum level of cholesterol and triglycerides in women? *Anthropological Review* 69: 37–47.

Dix, Barbara, Stankiewicz Błażej, Oliwia Ligman & Walery Zukow. 2013. Somatic characteristics rowers from secondary school nr 10 in Bydgoszcz. *Journal of Health Sciences* 3(7): 151–66.

Fett, Carlos A., Waleria C.R. Fett, Sandra R. Oyama & Julio S. Marchini. 2006. Body composition and somatotype in overweight and obese women pre- and post-circuit training or jogging. *Revista Brasileira de Medicina do Esporte* 12: 39e–43e.

Genovese, Jeremy E. C. 2009. Can Body Mass Index (BMI) be used as a proxy for somatotype? *The Social Science Journal* 46(2): 390–3.

Jarosz, Mirosław (eds.). 2012. *Normy żywienia dla populacji polskiej - nowelizacja*. Warsaw, Instytut Żywności i Żywienia.

Kaarma, Helje, Liidia Saluste, Mart Lintsi, Jaan Kasmel, Gudrun Veldre, Ene-Margit Tiit, Säde Koskel & Andres Arend. 2008. Height and weight norms for adult estonian men and women (aged 20-70 years) and ways of somatotyping using a height weight classification. *Papers on Anthropology* 17(1): 113–30.

Maddan Sean, J. T. Walker & J. M. Miller. 2008. Does size really matter? A reexamination of Sheldon's somatotypes and criminal behavior. *The Social Science Journal* 45(2): 330–4.

Malinowski, Andrzej & Jan Strzałko (eds.). 1985. *Antropologia*. Warsaw, PWN (Polish Scientific Publishers).

Malinowski, Andrzej & Jan Strzałko (eds.). 1997. *Antropologia*. Warsaw, PWN (Polish Scientific Publishers).

Pardo, Barbara, Danuta Szcześniewska, Agnieszka Waśkiewicz & Elżbieta Sygnowska. 2001. Nadwaga i otyłość i ich uwarunkowania środowiskowe w populacji mieszkańców prawobrzeżnej Warszawy. *Czynniki Ryzyka* 1/2: 58–67.

Peterson, Jana, Helje Kaarma & Säde Koskel,. 2012. An anthropometric model for nutrition research of Estonian female students. *Papers on Anthropology* 21(1): 201–11.

Pezala, Małgorzata & Walery Zukow. 2013. Somatic features of women's volleyball players Elementary School No. 31 in Bydgoszcz. *Journal of Health Sciences* 3(6): 7–18.

Rafter, Nicole. 2007. Somatotyping, antimodernism, and the production of criminological knowledge. *Criminology* 45(4): 805–33.

Raschka, Christoph & Susanne K. Aichele. 2014. Correlations between somatotypes and nutritional intake in sports students. *Papers on Anthropology* 23/2: 96–104.

Raschka, Christoph & Joanna Graczyk. 2013. Correlations between somatotypes and nutritional intake in members of a fitness studio. *Papers on Anthropology* 22(1): 145–52.

Singh, Swinder. P. & Promila Mehta. 2009. *Human body measurements: Concepts and applications*. New Delhi, PHI Learning Pvt. Ltd.

Sterkowicz-Przybycień, Katarzyna & Ryszard Żarów. 2005. Metody oceny budowy somatycznej a wielkość otłuszczenia młodych mężczyzn uprawiających sporty walki. In: *Promocja zdrowia w hierarchii wartości*. Annales Universitatis Mariae Curie-Skłodowska, Akademia Medyczna, Lublin Tom 5, pp. 261–6.

Turlejska, Halina, Urszula Pelzner, Lucjan Szponar, Eliza Konecka-Matyjek. 2004. *Zasady racjonalnego żywienia –zalecane racje pokarmowe dla wybranych grup ludności w zakładach żywienia zbiorowego*. Gdańsk, ODDK,.

WHO Expert Consultation. 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 362: 157–63.

Wolański, Napoleon. 2012. *Rozwój biologiczny człowieka*. Warszawa: PWN.

Povzetek

Prehrana je sestavni del oblikovanja maščobe in mišic ter vpliva antropometrične parametre. Merjenje rasti in telesne mase se lahko uporablja za ugotavljanje telesnega razvoja človeka. Parametre mase in višine lahko uporabljamo za določitev tipa telesa (somatotipa). Vzadnjem času somatotipe raziskujejo zaradi njihove povezanosti z različnimi boleznimi, vključno s tistimi, ki so povezane s prehrano. Študija je vključevala 154 študentk enega izmed varšavskih univerz, starih med 21 in 25 let, temeljila pa je na vprašalniku, sestavljenem iz dveh delov. Prvi je vseboval informacije o masi, višini, kraju prebivališča, prehranskih dodatkih, oceni zdravja in telesne dejavnosti. Drugi del je temeljil na tridnevnem prehranskem dnevniku. Merjenci so bili razdeljeni v tri skupine po somatotipu: ektomorfe, mezomorfe in endomorfe. Ženski ektomorfni somatotip porabi največjo količino energije, beljakovin, maščob, vitaminov B1, B6, bakra in retinola. Ženski mezomorfni somatotip porabi več ogljikovih hidratov kot druga dva tipa. Endomorfne ženske so imele velike težave pri vzdrževanju idealne telesne mase kljub dejstvu, da je njihova zaužita hrana zagotavljala najmanjšo količino energije, makrohranil ter izbranih vitaminov in mineralov. Somatotip, ki je tip človeške postave, vpliva na porabo energije in nekaterih hranil (beljakovin, maščob, vitaminov B1 in B6, bakra in retinola).

KLJUČNE BESEDE: somatotype, sestave telesa, prehrana, energija, hranilne snovi

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