The relationship of somatotype with the consumption of selected cereal and dairy products

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Abstract
The relationship between nutrition and the parameters of the human body have become an area of interest for scientists, nutritionists, and dieticians. The aim of the study was to investigate the relationship of somatotype (body type) with the consumption of selected cereal and milk products. The research was carried out in 2015. The study involved 75 women of different backgrounds. Among them were 25 women with ectomorphic physiques, 25 women with mesomorphic ones, and 25 women with endomorphic ones. To assign the women to the appropriate somatotype, the Rohrer index (RI) was used. An equal number of women of each of the three somatotypes was selected. The survey consisted of two sections: the first was concerned with anthropometric and socio-demographic data, as well as the eating habits and health of the subjects, and the second was a frequency of consumption questionnaire, in which the cereal products were divided into 13 groups and the dairy products into 14 groups. In addition, the subjects were asked to complete a table with commonly consumed portions size of each of the food products. There seems to be a relationship between the body physique or somatotype and the qualitative and quantitative consumption of cereal products in women. Body type affects the consumption of milk, yogurt, kefir, buttermilk, cream cheese, smooth cottage cheese, and cream of more than 20% fat. There is a need for further and more detailed studies on the relationship between the somatotype and the consumption of various food groups in order to confirm the obtained results.

KEYWORDS: women, somatotype, cereal products, dairy products

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Introduction

Of all living creatures, humans show some of the highest individual variability. Each person is different and there are no two individuals in the world who do not differ from each other even by a smallest detail, external or genetic (Kagawa et al. 2009). Somatotype can be defined as a type of the human body physique (Charzewski et al. 2004). The main factor that determines the somatotype, however, is genetic makeup; environmental factors such as diet, physical activity and lifestyle also affect human physique (Malinowski & Strzałko 1997). Body type is described by the its shape, and in anthropology is expressed as a somatotypological aspect. The Sheldon classification is one of the most popular somatotype classification; its subsequent modifications, which describe three body types: endomorphic, mesomorphic and ectomorphic. This classification is based on the genetic determination of the degree of tissues development. The predominant tissue of the endomorphic body is fat, of the mesomorphic body is muscle, and of the ectomorphic is bone (Malinowski & Strzałko 1997; Fett et al. 2006). In endomorphic physique, there is the prevalence of epithelial tissue, fat, and internal organs. The mesomorphic body is characterised by a highly developed bone and muscle tissues, and the ectomorphic one is distinguished by the prevalence of neural tissue (Singh & Mehta 2009).

The somatotype is affected by the fat and muscle content, weight, and height of a person. It is, therefore, reasonable to assert that the physique can be associated with the occurrence of certain diseases. Research in this area has been conducted by Sheldon (Singh & Mehta 2009). Currently there are studies carried out on the effect of somatotype on the occurrence of diseases. Furthermore, a high Rohrer index has been linked to diabetes, which has been confirmed by Baltadjiev (2013) and Yadav et al. (2007). A relationship between somatotype and cancer has also been studied. Ronco et al. (2012), and Dettenborn et al. (2008) demonstrated the relationship between endomorphic physique and body fat content and the incidence of breast cancer in women. Buffa et al. (2007) demonstrated a relationship between higher rate of ectomorphic somatotype and Alzheimer's disease.

The least investigated factor associated with the somatotype is diet, which is why this aspect requires further studies at this moment. Peterson et al. (2012) demonstrated that there is a positive correlation between the amount of food consumed and the density of the body and a negative correlation between the amount of food consumed and its weight, body size, and skinfold thickness. It has also been shown that the food consumption per kilogram of body mass was lower in endomorphs than in ectomorphs. There was, however, no significant correlation between the protein intake and anthropometric parameters.

Materials and methods

Subjects

The research was carried out in 2015. The study involved 75 women from different socioeconomic backgrounds. Among them were 25 women with ectomorphic physiques, 25 women with mesomorphic ones, and 25 women with endomorphic ones. The recruitment of the research subjects was intentional. The selected women were healthy and aged 20-30 years. An equal number of women of each of the three somatotypes was selected. The

exclusion criteria were chronic diseases, weight-loss diet, gluten-free diet, pregnancy, breastfeeding, and professional sport.

Consumption of selected food products

The survey consisted of two parts. The first concerned the anthropometric and socio-demographic data, and the eating habits of the subjects. The second was Block's frequency of consumption questionnaire for cereal products, milk, dairy products, and butter (Block & DiSogra 1994). Cereal products are divided into 13 groups such as wheat bread, mixed bread, wholemeal /Graham/rye bread, crisp bread, groats, rice, rice cakes, pasta, breakfast cereals, oatmeal/rye/millet/barley etc., muesli, pastries/cakes/bran. Dairy products were divided into 14 groups: 0-0.5% fat milk, >1.5% fat milk, natural yogurt, kefir and buttermilk, flavoured yogurt, kefir and buttermilk, dairy desserts, cream cheese, low-fat cottage cheese, semi-skimmed and fat cottage cheese, rennet cheese, blue cheese, processed cheese, 9-18% fat cream and 20% fat cream. Selection of products used in the survey was made on the basis of data on food consumption from Household Budget in 2013 (Central Statistical Office 2014). Block's questionnaire contained a table in which the subjects gave the frequency of consumption on a five-point scale: a few times a day, every day, several times a week, several times a month, less than once a month/never. Furthermore, the subjects completed a table of commonly consumed portions of each of the food products. Every single portion of each product was then calculated into a daily intake quantity.

Anthropometric measurements

To assign the women to the appropriate somatotype the Rohrer index (RI) was used: (RI) = (weight [g] × 100) / (height [cm])^3 (Pezala et al. 2013). The subjects were divided into three groups using Sheldon's classification and Curtius' key: ectomorphic RI < 1.28, mesomorphic RI = 1.29-1.46 and endomorphic RI > 1.47 (Sterkowicz-Przybycień & Żarów 2005).

In addition, BMI (Body Mass Index) was calculated, and the subjects were divided into the following groups: underweight (BMI < 18.5), normal weight (BMI: 18.5-24.9), overweight (BMI: 25-29.9), first degree obesity (BMI: 30-34.9) and second-degree obesity (BMI: > 35) (WHO 2004).

Statistical analysis

Statistical analysis was done using PS IMAGO 4.0 software (IBM SPSS 24). The values of consumption of selected food products were expressed as mean and standard deviations, demonstrating the individual variability, median, minimum, and maximum values. To analyse quantitative data, one-way ANOVA was used, while a Chi^2 test was used to process the qualitative data. Pearson correlation coefficients for the Rohrer index and some variables was calculated, but only for these variables with significantly different values between somatotypes. The paper also presents statistically significant Spearman's correlation coefficients between somatotype and the consumption of cereal and milk products. In all analyses, the p-value ≤ 0.05.

Results

The average age of the ectomorphic subjects was 22.4 years, the mesomorphic ones 22.7 years, and 21.4 years for the endomorphic subjects. Most of the women had secondary (72%) or higher education (26%). The women came from different backgrounds and lived in cities with different populations. The age of the women, education, and place of residence had no statistically significant effect on their somatotype.

The study showed that the highest body mass characterised endomorphic women (73.0 ± 15.0 kg), followed by mesomorphic ones (60.9 ± 5.53 kg) and ectomorphic ones (55.2 ± 6.28 kg) ($p \leq 0.0001$). According to height, the ectomorphic subjects were the tallest (169 ± 5.34 cm), then mesomorphic ones (165 ± 4.90 cm), and the endomorphic ones (164 cm ± 6.75) ($p = 0.002$).

On the basis of the data the RI value was calculated for each subject, and then they were classified into the appropriate somatotype group. The mean value of RI for ectomorphs was 1.13 ± 0.10, for mesomorphs 1.35 ± 0.06, and for endomorphs 1.65 ± 0.21 ($p \leq 0001$).

The average BMI for each somatotype was also calculated from the obtained anthropometric data. In the group of endomorphs, it exceeded the normal body weight (27.1 ± 4.00 kg / m²). Average BMI among both ectomorphs (19.2 ± 1.67 kg/m²) and mesomorphs (22.3 ± 1.01 kg/m²) were within normal ranges. The further analysis showed statistically significant differences between the somatotype and BMI ($p \leq 0.0001$).

Most of the subjects from all three somatotype groups rated their physical activity as average and described their leisure time as active ($p > 0.05$) (Table 1). The highest percentage of women who consumed five meals per day was from among the ectomorphs (40% of subjects), while five meals per day were consumed mainly by the endomorphs (56% of subjects) ($p > 0.05$) (Table 1). Most of the subjects, regardless of physique, declared snacking between meals ($p > 0.05$), as well as not eating meals at fixed times ($p > 0.05$) (Table 1).

Table 1: Physical activity and eating habits of the women with different somatotypes (%)

	Endomorphic	Mesomorphic	Ectomorphic	p-value*
Physical activity				
low	28	24	24	0.825
average	56	64	52	
high	16	12	24	
Sport training				
every day	16	20	4	0.540
2-3 per week	32	28	48	
1 per week	36	36	40	
none	16	16	8	
Leisure				
active	92	72	72	0.137
Number of meals per day				
5 meals	12	24	40	0.256
4 meals	56	48	20	
3 meals	32	28	28	
2 meals	0	0	12	
Snacking				
yes	92	76	80	0.298
Regular eating				
no	76	52	52	0.135

Chi^2 Pearson test

The study also examined whether there were differences between somatotypes in the average daily intake of selected cereal products (Table 2), milk, dairy products, and butter (Table 3). There were statistically significant differences found in the consumption of pasta and cakes, biscuits, and pastries between different groups (Table 2).

Table 2: Average daily intake of selected cereal products [g/day]

Product	Endomorphic	Mesomorphic	Ectomorphic
Wheat bread	37.5±21.41 25.82 12.6-90.03	42.3±31.3 25.8 12.6-120	58.8±49.5 50.0 21.5-180
Mixed bread	26.8 ± 13.3 27.7 3.2-50	31.9±24.3 21.5 12.6-80.0	23.4±13.8 22.6 7.35-50.0
Wholemeal bread, graham, rye bread	43.1±36.9 27.7 7.35-120	64.2±61.2 34.7 12.6-245	51.5±36.9 35.0 12.6-140
Crispbread	11.8±9.98 10.8 2.00-30.0	10.4±12.9 6.3 1.20-36.0	9.46±8.15 5.30 2.00-25.0
Groats	15.2±7.96 10.5 6.00-42.0	16.5±11.9 10.5 2.15-43.0	18.7±11.3 13.8 8.40-50.0
Rice	20.6±10.6 21.0 10.5-50.0	23.5±19.1 19.1 10.5-84.0	33.2±29.7 21.5 10.3-140
Rice waffles	13.2±15.6 9.55 4.20-70.0	8.80±6.71 7.35 1.60-21.5	14.9±15.8 9.55 2.00-55.9
Pasta	21.5±8.81b 21.0 10.5-43.0	21.3±8.45b 21.0 10.5-42.0	36.9±26.5a 31.5 16.8-130
Breakfast cereals	19.1±16.7 10.5 5.00-50.0	28.3±32.7 17.2 2.80-120.0	18.2±10.0 16.5 4.20-40.0
Oatmeal, rye / millet	8.39±6.86 7.95 1.20-25.8	13.6±7.15 12.6 4.30-31.5	10.8±5.34 10.5 4.20-21.5
Muesli	15.5±14.9 10.5 4.20-50.0	15.1±17.5 8.40 1.20-50.0	23.7±25.5 13.7 4.20-86.0
Cakes, cookies, pastries	19.8±14.3b 18.0 4.00-51.6	31.6±25.3b 25.2 6.30-103	54.3±36.3a 51.6 12.9-120
Bran, germ	8.50±5.29 8.40 4.20-17.2	4.89±2.99 4.25 1.05-10.0	7.65±5.41 6.38 3.15-20.0

[1]mean±standard deviation, [2]median, [3]minimum-maximum; a, b – values marked with the different characters differ significantly, p≤0,05; values marked with the same character do not differ significantly, p>0,05; post hoc Tukey test

The ectomorphic subjects consumed significantly more of these products in comparison to the mesomorphic and endomorphic ones. Regarding the average daily intake of other cereal products, there were no statistically significant differences between somatotypes in this respect. The study also showed that the mesomorphic women consumed significantly more than two other somatotype groups of the following products: 0-0.5%-fat milk, yogurt, kefir, natural buttermilk, cream cheese, and cream of more than 20% fat. They also consumed less homogenised cheese compared to ecto- and endomorphic women ($p \leq 0.05$) (Table 3).

This study also examined the correlation between the RI and the consumption of some cereal and milk products. It has been found that the somatotype, determined by RI value, showed a statistically significant correlation with the consumption of biscuits, cakes, and pastries ($r = -0.336$; $p = 0.018$) and blue cheeses ($r = 0.460$; $p = 0.024$). In contrast, the somatotype defined by physique showed a statistically significant correlation with the consumption of pasta ($r = -0.363$; $p = 0.008$) as well as cakes, biscuits, and pastries ($r = -0476$; $p = 0.001$).

Table 3: Average daily consumption of milk [ml/day] and certain dairy products and butter [g/day]

Product	Endomorphic	Mesomorphic	Ectomorphic
Milk (0-0.5% fat)	106±82.91 ab 80.02 15.0-2503	200±142.9b 187.5 50.0-375	54.0±17.8a 48.0 40.0-80.0
Milk (>1.5% fat)	131±79.8ab 100 20.0-300	120±71.1b 100 20.0-250	224±188a 150 80.0-750
Yogurt, kefir natural buttermilk	64.9±37.5a 60.0 10.0-150	159±121b 100 40.0-450	90.8±57.1a 70.0 40.0-250
Yogurt, kefir flavoured buttermilk	70.9±50.1 50.0 20.0-200	127-128 80.0 50.0-450	65.4±38.5 60.0 20.0-160
Dairy desserts	34.8±23.2ab 30.0 20.0-100	13.4±10.7b 10.0 3.00-30.0	46.3±28.2a 30.0 24.4-120
Homogenized cheese	34.8±12.4a 30.0 24.0-60.0	20.8±14.2b 30.0 4.50-40.0	34.3±8.09a 30.0 27.0-52.0
Low-fat cottage cheese	40.6±56.7 22.0 14.0-200	17.5±15.2 15.0 0.6-40.0	16.7±17.5 11.0 1.50-60.0
Semi-skimmed and fat cottage cheese	15.5±10.5 15.0 2.00-40.0	29.5±37.1 20.0 10.0-150	13.9±10.5 11.0 1.50-40.0

Rennet cheese	15.4±8.41	13.6±9.38	17.7±13.5
	12.0	12.0	12.0
	4.00-30.0	2.00-40.0	6.00-60.0
Blue cheese	21.9±30.3	10.9±8.95	4.89±4.46
	7.50	12.0	3.50
	1.20-80.0	0.30-24.0	0.60-12.0
Cream cheese	6.03±3.69a	20.6±18.3b	6.01±4.89a
	6.00	12.0	4.00
	0.60-12.0	5.00-60.0	0.60-20.0
Processed cheese	3.83±3.54	2.32±1.71	3.81±2.96
	2.00	1.50	3.00
	0.60-10.0	0.30-5.00	0.75-8.00
Cream (9-18% fat)	5.22±5.37	8.47±4.76	5.68±4.39
	4.00	10.0	4.00
	0.30-20.0	2.00-20.0	0.60-16.0
Cream (>20% fat)	1.57±1.59a	10.4±6.94b	2.15±1.98a
	0.90	9.00	2.00
	0.30-4.00	3.60-20.0	0.30-6.00
Butter	7.50±9.78	6.43±6.69	8.59±9.07
	5.00	4.00	5.00
	0.15-36.0	0.30-25.0	0.15-30.0

[1]mean±standard deviation, [2]median, [3]minimum-maximum; a, b – values marked with the different characters differ significantly, p≤0,05; values marked with the same character do not differ significantly, p>0,05; post hoc Tukey test

Discussion and conclusion

In this study, the Rohrer index decreased with the increase of average height of the subjects. The lowest average height was found in endomorphic subjects, and the highest in ectomorphic ones. The study of Pezala et al. (2013) carried out on female volleyball players from elementary schools in Bydgoszcz, Poland, also shown that ectomorphs were taller than their peers of different physique.

Daily sport was the rarest among ectomorphic subjects; however, most of them trained two to three times a week. Studies on the physique of the athletes show that people who are physically active, attending sports classes and professional athletes mostly have either ectomorphic or mesomorphic physiques.

The average BMI of endomorphic subjects exceeded normal values, while for both ectomorphs and mesomorphs they were within normal ranges. In all three groups, there were subjects with normal body weight but in various proportions. Among mesomorphs, all the subjects had a normal weight. Among ectomorphs, almost all had normal weight, and only a few were underweight; none were overweight. In the Bydgoszcz study, conducted on a group of female basketball players all ectomorphs had a normal body weight indicated by their BMI (Putkamer et al. 2014).

Studies on the anthropometric parameters of the human body, in most cases, confirm that BMI is not entirely accurate in assessing a person's physique. Even with very

similar BMI, there may be different somatotypes (Kaarma et al. 2008).

The data on the frequency of sport training showed that endomorphs, often characterised by excess body weight, practiced sport more often than the subjects with normal body weight did. Endomorphs also regularly ate four meals a day. These results suggest that endomorphic women give greater consideration to proper lifestyle, probably because of the need to reduce weight.

In the literature, there is scarce information about the relationship of somatotype with the consumption of various food groups such as cereal or dairy products. Until now, researchers have mostly dealt with aspects such as intake of energy, macro and micronutrients and general anthropometric parameters. This study can be, therefore, considered a pioneering one.

Somatotype is not significantly related with the consumption of cereal products. However, there was an increased consumption of such products in mesomorphs, especially wholemeal and mixed bread. Taking into account the high muscle mass percentage in mesomorphs, it can be concluded that they exhibit the highest basal metabolic rate (Lazzer et al. 2010). This may require increased energy supply, which can easily be achieved through the consumption of cereal products.

Endomorphic women, the group with the highest percentage of excess body fat, consumed the fewest cereal products with a high proportion of simple sugars, and low-density nutrition (rice, pasta). There was an opposite trend among thin, ectomorphic individuals. This suggests that the endomorphic women strive to reduce their body weight through dietary restrictions of the abovementioned food products, which are thought in popular opinion to induce weight gain (Lebiedzińska 2007).

Currently, there are no studies that have examined the relationship of somatotype with milk, dairy products, and butter consumption. Therefore, it is difficult to compare the results of this study with the available literature. Nevertheless, there are publications concerning the consumption of these products by adults (Przysławski et al. 2012, Mojka & Biel 2012, Kowalska 2010).

In conclusion, there is a relationship between the physique or somatotype and the qualitative and quantitative consumption of cereal products in women. Somatotype is related the consumption of milk, yogurt, kefir, buttermilk, cream cheese, homogenised cheese, and cream of more than 20% fat. Further and more detailed studies on the relationship between the somatotype and the consumption of various food products are needed.

Conflict of interest

The authors declare no conflict of interest.

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Povzetek

Odnosi med prehrano in parametri človeškega telesa, so postali zanimivo raziskovalno področje za znanstvenike, nutricioniste in dietetike. Namen raziskave je bil raziskati odnos somatotipa ali tipa telesa na porabo žitaric in mlečnih izdelkov. Raziskava je bila izvedena v letu 2015. V študijo je bilo vključenih 75 žensk iz različnih družbeno-ekonomskih okolij. Med njimi je bilo 25 žensk ektomorfnega, 25 mesomorfnega 25 endomorfnega tipa. Za razvrščanje v skupino somatotipa je bil uporabljen, Rohrerjev indeks (RI). Enako število žensk vseh treh somatotipov je bilo načrtno izbranih. Raziskava je bila sestavljena iz dveh delov: prvi je zajemal antropometrične in socio-demografske podatke, prehranjevalne navade in zdravje, drugi pa pogostost uživanja žitaric in mlečnih izdelkov, kjer so bili žitni izdelki razdeljeni v 13, mlečni pa v 14 skupin. Poleg tega so udeleženke izpolnile tabelo, v kateri je bila navedena pogostnost uživanja vseh živil. Pokazala se je povezanost med somatotipom ter kakovostno in količinsko porabo žitaric pri ženskah. Somatotip je povezan tudi s porabo mleka, jogurta, kefirja, pinjenca, svežega sira, gladke skute in smetane z več kot 20 % maščobe. Potrebne so nadaljnje in bolj podrobne študije o povezanosti somatotipa s porabo različnih skupin živil za potrditev predstavljenih rezultatov.

KLJUČNE BESEDE: ženske, somatotip, žitni izdelki, mlečni izdelki

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