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ARTICLE

The correlation between parameters indicating obesity and certain environmental factors

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ABSTRACT The present study deals with the effects of socio-economic and lifestyle factors on the nutritional status of young adults. 627 university students from the University of Szeged, Hungary participated voluntarily in the survey. In order to illustrate their nutritional status, we determined the body mass index (BMI), the waist circumference (WC) and the waist-to-hip ratio (WHR). According to the BMI, 18.4% of the students are somewhat overweight, 64.8% among them show signs of abdominal fat distribution. Based on the aftereffects of the logistic regression, the most important factors influencing the nutritional status include the parents' level of education, the meals consumed and the frequency of sweets consumption. Among the parameters pointing to obesity, the BMI is the most precise indicator of the external environmental impacts.
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KEY WORDS

body mass index
waist circumference
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university students
lifestyle factors

Nowadays, obesity is one of the most important health problems. There are about 315 million adults whose body mass index exceeds the limit of the obese category, determined by the WHO (Caterson and Gill 2002). The long-term disorder of the energy balance results in the critical accumulation of adipose tissue, which will eventually lead to overweight and obesity. Furthermore, this will increase the risk of the development of a number of life threatening diseases. In the European Union, most of the death cases are caused by diseases related to obesity, such as cardiovascular diseases, cerebrovascular diseases, diabetes mellitus, cancerous diseases and chronic liver diseases (Elmadfa and Weichselbaum 2004). In addition to healthcare problems, obesity is also a serious financial burden both for the society and on the shoulders of the overweight individual (Gyenis and Joubert 2005).

Today, we have a great number of methods to define accurately the quantity and the distribution of body fat. Underwater weighing (densitometry), multi-frequency bioelectrical impedance analysis and magnetic resonance imaging are to be found among the best-known methods. However, these methods are relatively expensive and their realization is rather difficult when there are so many people involved. In epidemiological and clinical examinations with such large case numbers, the thickness of the skin fold and / or the body mass index (BMI) are primarily determined in order that the scale of obesity can be estimated, because apart from being simple, they also show good correlation with the quantity of the body fat (Dehghan et al. 2005; Chakraborty et al. 2009). Abdominal fatness, as the cause of visceral fat accumulation, is an intensified risk factor of metabolic (such as the diabetes mellitus (type 2), hypertension, dyslipidaemia) and cardiovascular diseases. The distribution of the body fat can easily be estimated through measuring the waist circumference (WC) and calculating the waist-to-hip ratio (WHR), (Tanyolaç et al. 2007).

Although the molecular biological background of obesity is a highly researched field (Rankinen et al. 2006), the basic causes of its epidemiological spread are associated with the exceptional changes in the environmental and lifestyle factors (physical inactivity, excessive calorie intake, bad nutritional habits, urbanization, motorization), (Martínez-González et al. 1999; Bellisle et al. 2004; Dehghan et al. 2005). The purpose of our study is the examination of the correlation between the 3 parameters indicating obesity (BMI, WC, WHR) and certain socio-economic and lifestyle factors in one selected layer of Hungarian young adults.

Materials and Methods

The data to be analyzed were collected among the students of the University of Szeged, from March through April, 2007. We measured and put down four anthropometric characteristic features – the body height, the body weight, the waist circumference and the hip circumference – of a total of 627 students (190 male and 437 female individuals). Weight was measured to the nearest 50 gram on a medical scale, height was measured in millimeters with an anthropometer and the waist circumference (WC) and hip circumference (HC) were taken with an anthropological measuring tape. Measurement of waist circumference was performed midway between the lateral lower ribs and the iliac crests while the subject

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Table 1. Parameters of body measurements and indices of the university students.

Subjects	Boys			Girls		
	n	Mean	SD	n	Mean	SD
Body height**	190	178,9	7,20	437	164,9	6,36
Body weight**	190	75,4	13,60	437	59,8	10,26
BMI**	190	23,5	3,70	437	22,0	3,53
Waist circumference**	190	81,6	9,26	437	70,4	7,65
Hip circumference**	190	88,6	8,87	437	86,2	8,61
Waist-to-hip ratio**	190	0,9	0,05	437	0,8	0,06

** Statistical significance at $p < 0.01$ level.

Table 2. Distribution of university students according to BMI categories.

Subjects	Boys		Girls		Total	
	n	%	n	%	n	%
Underweight	12	6,3	41	9,4	53	8,5
Normal	123	64,7	336	76,9	495	73,2
Overweight**	45	23,7	45	10,3	90	14,4
Obese**	10	5,3	15	3,4	25	4

** Statistical significance at $p < 0.01$ level.

Table 3. Distribution of universty students by the WC and WHR groups.

Subjects	Boys		Girls		Total	
	n	%	n	%	n	%
No health risk	171	90	396	90,6	567	90,4
Health risk	19	10	41	9,4	60	9,6
Abdominal fat distribution*	136	71,6	270	61,8	406	64,8
Peripheral fat distribution	54	28,4	167	38,5	221	35,2

* Statistical significance at $p < 0.05$ levels.

was standing, after a moderate expiration. We measured the circumference of the hip as the grid lined on the anterior iliac spine on the abdomen running all around the body in a horizontal position.

In order to estimate overweight, obesity and other health risks, we calculated the body mass index (BMI) and waist-to-hip ratio (WHR). For the categorization of the BMI and WC values, we took into consideration the recommendations of the World Health Organization (WHO), (James et al. 2001), while in the case of the waist-to-hip ratio, we used the limits of 0.8 for women and 0.9 for men (Rodé 1998) to separate abdominal fat distribution from peripheral fat distribution. During the survey, we used questionnaires to gather the required information about the students' lifestyle and socio-economic background.

We carried out the statistical analysis of the measured data using SPSS for Windows. In order to examine the differences between the averages and frequencies occurring in the particular groups, we referred to ANOVA and Chi-square test. In the first step of the logistic regression all variables were included in the analysis. Afterwards, the "Forward Stepwise" method was used which included in the analysis only variables which had a significant influence on the dependent variables. The two categories of the first dependent variable are the following: BMI 25 (0) and BMI>25 (1). The categories of the second dependent variable are as specified here: based on the waist circumference there is some health risk (1), there is no health risk (0). The third dependent variable shows either peripheral fat distribution (0) or abdominal fat distribution (1). We worked with a 5% significance level throughout the analyses.

Results

Table 1. displays the mean and standard deviation values of body height, body weight, BMI, waist circumference, hip circumference and WHR, in accordance with gender distinction. In the case of male students, the mean values were always significantly higher than those measured for female students ($p<0.0001$). The most significant standard deviation occurred in connection with body weight, which proves very well that extremes could also be found in the sample material ($min_{males}=44.6$; $max_{males}=131.9$). Both the average of the male students and that of the female students lie within boundaries of the normal category, as determined by the WHO. In neither gender group do the averages of waist circumference exceed the limit indicating health risk. On the other hand, the analyzed samples show that, according to the average of the waist-to-hip ratio, the individuals in both gender groups bear higher health risks as they fall into the category of abdominal fat distribution.

In accordance with the BMI categories, the students' proportional distribution figures in Table 2. In the case of male students, the frequency of those being overweight is much higher (29%) than in the case of female students (13.7%), thus the difference is statistically significant ($p<0.0001$). On

Table 4. Results of logistic regression analyses.

Variables	Based on the BMI		Based on the WC		Based on theWHR	
	Coefficient	p	Coefficient	p	Coefficient	p
Size of habitation (>100.000 inhabitants)		0,288		0,208		0,554
<10.000 inhabitants	0,085	0,780	-0,485	0,203	0,290	0,223
10.000 – 50.000 inhabitants	-0,093	0,741	-0,564	0,115	0,245	0,259
50.000 – 100.000 inhabitants	-1,034	0,078	-1,320	0,094	0,327	0,360
Educational level of father (high level)		0,101		0,943		0,035*
Unfinished elementary	2,696	0,031	-19,471	0,999	-0,628	0,497
Elementary	0,574	0,418	0,132	0,890	0,383	0,505
Medium level	-0,127	0,656	-0,194	0,594	0,482	0,006**
Educational level of mother (high level)		0,009**		0,120		0,663
Unfinished elementary	-19,502	1,000	0,852	1,000	-21,662	1,000
Elementary	1,554	0,001**	1,526	0,027	0,617	0,282
Medium level	0,389	0,048*	0,654	0,074	0,194	0,361
Sports activity (every day)		0,332		0,795		0,104
Several times/week	0,908	0,259	-0,475	0,579	0,209	0,683
1-2 occasion/week	0,440	0,579	-0,367	0,657	-0,299	0,541
No sport activity	0,438	0,580	-0,125	0,877	-0,410	0,399
Frequency of daily eating (more than three times)		0,000***		0,001**		0,897
Once a day	-19,163	0,999	-17,795	0,999	-0,182	0,891
Two times	1,591	0,000***	2,191	0,000***	0,149	0,644
Three times	0,574	0,067	1,337	0,007**	0,011	0,960
Randomly	0,346	0,341	0,882	0,116	-0,169	0,520
Time of the main meal of the day (around noon)		0,796		0,972		0,601
In the morning	-0,676	0,410	0,362	0,663	-0,648	0,244
In the afternoon	-0,027	0,940	-0,079	0,866	-0,106	0,701
Randomly	0,146	0,625	0,030	0,940	0,109	0,641
Frequency of sweets consumption (daily)		0,004**		0,079		0,042*
2-3 occasions/week	0,598	0,035*	0,698	0,077	0,033	0,866
Every week	0,915	0,004**	1,199	0,005	0,777	0,004**
Rarely	1,271	0,001**	0,982	0,065	0,110	0,727
Never	-0,454	0,675	0,340	0,768	0,037	0,950
Frequency of fruits consumption (daily)		0,369		0,995		0,643
2-3 occasions/week	-0,341	0,181	0,036	0,912	-0,197	0,322
Every week	-0,701	0,063	-0,163	0,724	-0,197	0,478
Rarely	-0,213	0,773	-19,007	0,998	-0,742	0,177
Never	0,421	0,753	-19,291	0,999	-21,469	0,999

Calculations referred to category where lowest prevalence of overweight and obesity in students is expected, i.e. always to category of the variable in parentheses.
* Statistical significance at $p < 0.05$ levels. ** Statistical significance at $p < 0.01$ level.

he other hand, in the category of underweight students, the proportion of female students is higher, although the difference is not significant (p=0.205).

Table 3. displays the existence of health risk estimated on the basis of the waist circumference, as well as the type of fat distribution. Based on the waist circumference no health risk could be seen in 90.4% of the students we examined, while in 10% of the male students and 9.3% of the female students it could be detected. The difference between the genders is not significant (p=0.320). As far as the waist-to-hip ratio is concerned, in case of both genders, the abdominal type of fat distribution occurred with significantly higher frequency (p=0.018), (males 71.6%, females 61.8%).

The results of the logistic regression are summarized in Table 4. The mothers' education levels have a significant effect of their children's overweight and obesity determined by the BMI. The risk of overweight is higher in the case of the children whose mothers have a lower level of schooling. Ac-

Table 5. Odds ratio and confidence interval of statistically significant risk factors by BMI, WC and WHR.

	BMI		WC		WHR	
	OR	95% CI for OR	OR	95% CI for OR	OR	95% CI for OR
High educational level of mother	4,732	1,889 – 11,857				
Medium educational level of mother	1,476	0,944 – 2,307				
Medium educational level of father					1,620	1,149 – 2,283
Frequency of daily eating: two times	4,909	2,381 – 10,121	8,948	3,128 – 25,601		
Frequency of daily eating: three times			3,808	1,442 – 10,055		
Frequency of sweets consumption: 2-3 occasions/week	1,818	1,042 – 3,172				
Frequency of sweets consumption: Every week	2,497	1,340 – 4,655			2,175	1,286 – 3,679
Frequency of sweets consumption: Rarely	3,566	1,720 – 7,394				

OR-Odds ratio; CI-Confidence interval

cording to our research results, there is a significant correlation between the frequency of daily meals and the prevalence of overweight. Finally, the frequency of sweets consumption also affects the emergence of the risk of overweight (and thereby of the BMI). As for the other independent variables, (the father's level of education, the size of the habitation, the frequency of regular sporting, the time of the main meal, the frequency of fruit and vegetable consumption) the model did not depict any significant effect. We examined the effects of the same independent variables on the existence of health risk estimated on the basis of the waist circumference, as well as on the type of fat distribution. As far as the waist circumference is concerned, only the frequency of the daily meals proved significant, on the other hand, as for the type of fat distribution, the frequency of sweets consumption and the fathers' education levels showed significant effects.

Table 5. presents the values of the odds ratios (OD) and their confidence interval (CI) of those factors witch were included by the Forward Stepwise method in the logistic regression as being significantt. The disposition to overweight according to the BMI is almost five times higher (4.73) when the mothers' level of schooling is only elementary, while it is just one and a half times higher (1.48) when the mothers' education is at a medium level. The consumption of two daily meals almost quintuples (4.9) the risk of overweight. Those who rarely consume sweets have a higher inclination to overweight, which drops progressively with the increase of the frequency of sweets consumption.

Taking in consideration the waist circumference, we can state that the disposition for passing over the limit of health risk is nine times (8.95) higher among those who eat twice a day. As for the waist-to-hip ratio, the children of fathers with a medium level of education are 1.6 times more inclined to abdominal fat distribution than the children whose fathers possess degrees of higher education. Those who do not consume sweets regularly every day have a 2.12 times higher inclination to abdominal fat distribution than the ones whose sweets consumption is on a daily basis.

Discussion

The students' BMI means (male students – 23.5 and female students – 22) fall into the normal category as determined by the WHO. Our results are similar to those reached by Kiss et al. (2008, 2009) during their examinations carried out at Semmelweis University. According to the BMI, the proportion of the overweight students shows a frequency of 18.4%, which includes 29% of the male students and 13.7% of the female students. Antal et al. (2006) involved 264 Budapest university students into their research. They depicted obesity in case of 27% of the male students and 11.3% of the female students; these data correspond with our results. The BMI means in the examined samples and the frequency of the overweight are proportional to the scaling up tendency shown by Hungarian university students that Gyenis (1994) described earlier.

The prevalence of obesity among the adult population of Hungary is rather high: 41.8% of men are overweight and 17.1% of them are obese, while the proportion of overweight women is 31.3%, with 18.2% of obese women (Rodler et al. 2005). Several factors may stand in the background of the fact that in the case of the university students we examined the proportions of overweight and obesity were lower than the national averages. This is partially due to the university students' younger age and higher levels of education and intellectual accomplishment (Halkjær et al. 2003). On the other hand, our personal experiences reveal that more corpulent students simply refused to take part in the survey.

On the basis of the WHR, the proportion of abdominal fat distribution is relatively high in our sample (64.8%), however, according to the WC, the number of students revealing health risk due to abdominal fat accumulation is very low, concerning only 9.6%.

According to our findings, the three parameters indicating overweight and obesity estimate very differently the extent and risks of obesity. The difference between the frequencies defined by WC and BMI is double, whereas WHR reveals that the abdominal fat distribution risk factor is 6.75 times higher in our sample compared to the risk category determined by WC. Although none of the above markers is sufficient enough on its own to determine the amount of total body fat, a great number of studies report that the WC is by far a better indicator than the WHR of the accumulation of body fat and the risks of cardiovascular diseases (Taylor et al. 2000; Dobbelsteyn et al. 2001; Katzmarzyk et al. 2004; Picon et al. 2007).

Among the socio-economic and lifestyle factors we studied, the parents' level of education and some of the nutritional habits (number of the daily meals, frequency of sweets consumption) had statistically proven effects on obesity. In the case of both parents, the lower their level of education is, the higher risks their children have for overweight and the development of abdominal fat distribution. These findings agree with the results of the examinations carried out by Gyenis (1994) and Cho et al. (2009). Unhealthy, irregular eating habits also correspond to the rising prevalence of obesity (Panagiotakos et al. 2008; Berg et al. 2009; Prochnik Estima et al 2009). According to our results, taking a meal twice a day increases considerably the risks of overweight and health problems estimated by WC. People having a day several meals with small portions, as suggested by the principles of the healthy diet, will be less inclined to become overweight or obese. In the background of our findings about sweets consumption there stands the probable fact that students having smaller body weight do not have to worry about overweight, thus the frequency of their sweets consumption does not get influenced.

Our study seems to reveal that among the parameters indicating obesity BMI is the most sensitive to environmental effects, because this showed the most significant correlation with the independent variables. Obesity is also in correlation with several categories of the mothers' level of education, the number of the daily meals and the frequency of sweets consumption.

On the other hand, WC only bore the influence of the number of the daily meals, and WHR was just significantly affected by one category of the father's level of education and one category of the frequency of sweets consumption. Furthermore, even in the case of the regression models, the combination of the independent variables explained the biggest part (18.4%) from the BMI variance, as opposed to the variances of the WC (15.9%) and the WHR (9%). Consequently, the BMI – despite its frequent criticism – is a useful means to explore the exterior environmental factors that may be mentioned in connection with obesity.

In the layer of society university students represent, people do not take part in regular health screening examinations and their daily overload and irregular way of life present a lot of healthcare risks. The number of studies dealing with them is relatively low. Consequently, we should give much higher importance to such research involving university students as well as the extensive information and coverage on the basis of the acquired results.

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