

Relationship between diet and body fat percentage in female undergraduates

Authors' Contribution:

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B - Data Collection
C - Statistical Analysis
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E - Funds Collection

Rastislav Fec^{ABCD}, Alena Buková^{ADE}, Mirianna Brtková^{ABE}

University of P. J. Šafarik in Košice, Institute of Physical Education and Sport,
Slovakia

Abstract At the turn of the millennium obesity has become the most common metabolic disease due to changes in life conditions and lifestyle. The rise of overweight and obesity is the result of inadequate energy intake relative to its expense. Only 2 to 5% of all cases of overweight or obesity have objective medical causes. In view of energy balance, equally important to the amount of calories consumed is their distribution throughout the day. Other cases are clearly the result of improper lifestyle. A basic remedy to this condition appears to be an increase in the volume of regular physical activities and the establishment of an active healthy lifestyle. The aim of the research under the grant VEGA No. 1/1343/12 "Selected risk factors of obesity and its physical prevention" was to determine the relationship between selected factors of diet and the amount of body fat in female undergraduates. The study group consisted of female students at P.J. Šafarik University (n=620, average age=20.8 years). We examined the eating habits applying a non-standardized questionnaire compiled by ourselves. We followed the frequency of meals and their regularity, (breakfast, dinner), the time and quantity of the meals consumed in the evening hours. We determined the percentage of body fat using an Omron BF51 scale. We calculated the basic statistical characteristics (arithmetic mean, median). In order to detect statistically significant differences between particular variables, we applied the non-parametric Kruskal - Valis analysis of variance (H - test) and the Man - Whitney U test. Statistically significant differences in the percentage of fat was found in students divided into groups according to their responses regarding the variable "Frequency of meals" (p = 0.023), "Dinner regularity" (p = 0.001) and "Dinner time before bedtime" (p = 0.001). The research results show the importance of diet regularity and its optimal frequency. Especially important is the regularity of dinner, while the last meal should not be consumed later than 2 hours before bedtime.

Keywords: female undergraduates, body fat, diet, eating habits, frequency of meals, obesity

INTRODUCTION

Obesity in today's modern world represents a serious problem. It is a risk factor for cardiovascular diseases [1], diabetes [2,3], arthritis [4] and even cancer [5]. It is alarming that people do not show much interest in their state of health. For illustration, only 31 out of the 267

students at P. J. Safarik University expressed their interest in diagnosing their health and functional status. Worldwide occurrence of obesity doubled from 1980 to 2008 [7]. The increasing scientific and technological progress brings along a decreasing demand for physical activity, the growth in standard of living goes hand in hand with the increasing amount of available food, not but its quality. Increasing economic growth often means growing requirements regarding the amount of working time and a decreasing amount of free time, which is negatively reflected in the regime of diet. People in developed countries do not have enough time to eat regularly.

In view of energy balance, equally important to the amount of calories consumed is their distribution throughout the day. It is not only important what we consume, but also the regime of diet itself. To maintain optimum amount of fat, regularity of breakfast is important. High values of body mass index in adolescents are related to irregularity of having breakfast [8]. Breakfast helps to start running the processes of digestion and nutrient processing. The organism thus increases its energy expenditure and so prevents obesity. In a survey by authors Szajewska - Ruszczyński [9], 16 scientific studies were analyzed, of which 13 proved a preventive effect of breakfast towards obesity.

Except for having breakfast, another important factor is the frequency of meals. It influences the risk of obesity as early as in children and adolescents [10]. Less frequent meals mean higher amounts of calories consumed in one meal, which adversely affects the amount of body fat. Obese children consume 3 or less meals in the day, with a significantly higher caloric content per meal compared to children of normal weight [11]. The frequency of eating can affect insulin concentration and blood glucose levels [12]. Consumption of high calories per dose will increase the absorption of nutrients in the blood, one of which is glucose. A higher level of glucose will cause the exclusion of insulin, higher doses of which will make even the fatty tissue more sensitive to it. It is therefore necessary to maintain a rather constant level of blood glucose. Such state can only be maintained on a regular diet, so that the breaks between meals are not excessive. This requires a frequency of 5 to 6-meals a day.

Each component of the regime of diet contributes with its influence to a reduced risk of obesity. Some components have a significant impact, others can contribute to reducing obesity by their mutual combination. Our interest is focused on the components of dietary regime that could have significant relation with the amount of body fat in the general population.

The aim of the research is to determine particular components of diet that could significantly contribute to the amount of body fat in women attending university.

METHODS

The research was carried out in September 2012 on 620 female undergraduates studying at the University of Pavol Jozef Safarik in Kosice. The average age of women was 20.8 years with a standard deviation of 3.4. To identify their eating habits, we applied a non-standardized questionnaire compiled by ourselves. Part of the original questionnaire, presented in this paper and aimed at detecting the dietary regimen, consists of 5 questions. The questions represent independent variables in our research, and for easier handling they were titled as follows: Frequency - How many times a day do you eat? a) Once b) 2-times c) 3-times d) 4-times e) 5-times, f) 6-times or more. Breakfast - Do you have breakfast every day? a) yes b) mostly yes c) mostly not d) no. Dinner - Do you have dinner every day? a) yes b) mostly yes c) mostly not d) no. Dinner hour - If you have dinner in the evening, how long before bedtime is it mostly? a) do not have dinner b) 1hr c) 2hrs d) 3hrs e) 4hrs or more . Amount of food - The biggest amount of food you consume is mostly a) in the morning b) forenoon c) at lunch d) in the afternoon e) in

the evening f) the amount of food is evenly distributed.

The dependent variable, percentage of body fat, was determined using an Omron BF 511 body weight scale, which calculates body fat percentage based on weight and values of bioelectrical impedance. When processing the results, we calculated the arithmetic mean, standard deviation, median, and interquartile range. To detect statistically significant differences between the groups, divided according to their answers to each question, we used the non-parametric Kruskal - Valis analysis of variance (H - test). Based on this test, we determined the variables with a significant difference, i.e. the ones with potential correlation with the percentage of body fat. The Man-Whitney U-test was used to determine the significance of differences between the groups. Statistical significance was determined at $p < 0.05$.

RESULTS

The average body fat percentage in the study group was 27%, with a standard deviation of 9.3%. The median of body fat percentage was equal to 27%, with the lower quartile margin at 20.8% and the top at 33%. According to the Omron BF 551 manual, normal values of fat percentage for 18-39 year women fall within the range of 21% - 32.9%. The values below 21% shall be considered low, values of 33% - 38.9% are high, while very high levels are the ones above 39%. Our group thus falls within the range of normal values.

Table 1 gives a picture of monitored dietary habits of the surveyed sample. The largest percentage of respondents answered the question on the frequency of eating ("How many times a day do you eat?") stating they eat 3-times (35.6%) and 4-times (31.2%) during the day. A somewhat lower percentage (22.8%) eat 5-times a day. This means 89.6% of female students have a meal at least 3-times during the day. It follows that the eating habits of the surveyed sample, in terms of diet frequency, are not necessarily bad (Tab.1 Frequency).

We received somewhat less optimistic responses to the question of breakfast regularity ("Do you have breakfast every day?") (Table 1 Breakfast). Only 6.44% of respondents answered yes to the question. 43.5 percent of them do not have breakfast at all, which is worrying, and 29.1% stated they mostly do not have breakfast. Breakfast is, in terms of a healthy diet, essential in order to mobilize the body metabolism. We can conclude that the eating habits with respect to this variable are very poor, as more than 70% of the surveyed sample tend to omit breakfast.

Table 1 Percentual distribution of responses to each question of the questionnaire

No.	Question	a (%)	b (%)	c (%)	d (%)	e (%)	f (%)
1	Frequency (%)	0.16	7.25	35.59	31.24	22.87	2.74
2	Breakfast (%)	6.44	20.77	29.15	43.48	0	0
3	Dinner (%)	42.51	43.48	10.47	3.38	0	0
4	Dinner hours	3.06	10.47	28.02	36.88	21.26	0
5	Amount of food (%)	2.90	5.31	45.25	26.57	14.17	5.64

Legend: a, b, c, d, e, f, g, h - options of the individual responses to the questions (numbers indicate percentage), No. - question number

As many as 42.5% of respondents answered a definite "yes" to the question "Do you have dinner every day?", while the largest percentage of respondents (43.5%) answered a "mostly yes" and

only 3.8% of them do not have dinner at all. In terms of proper diet the evening dinner is equally important. The absence of dinner leaves the body without energy input for a long time, since during sleep there is no energy intake.

This results in slowing down of the metabolism and a higher tendency to store fat reserves. The data obtained suggest poor eating habits and a disorderly diet regime of the examined female college students. The following question was to find out how many hours before bedtime our respondents consume their last meal ("If you have dinner, how long before bedtime is it mostly ? "). The largest percentage of respondents (36.9%) consume their last meal three hours before bedtime. A lower percentage (28%) indicated a last meal eaten two hours before bedtime, 21.5% dine 1 hour before bedtime and 3% of respondents reported that they do not have dinner at all. The next question was there to find out when the respondents consume the largest amount of food ("The time you mostly consume the greatest amount of food"). The individual responses indicated that the largest amount of food was consumed at lunch (45.2%), 26.6% of them have it in the afternoon and 14.2% in the evening. 5.6% of the students reported an evenly distributed food intake, while 5.3% of respondents consume the largest amount of food during the forenoon and 2.3% in the morning.

Table 2 presents the results of the H-test, determining a statistically significant difference between the percentage of fat in the undergraduates divided into several groups according to their responses to each question. This test was used to sort out the variables with a potential relation with body fat percentage.

H-test results revealed statistically significant differences in the percentage of fat considering the variables Frequency, Dinner and Dinner Hour (tab. 2). Thus, the frequency of diet may have a significant relation with the amount of body fat, as well as the time of the last meal before bedtime. Based on the results of the H-test, we can conclude that whether or not the respondents had breakfast in our study, showed no significance in terms of body fat ($p = 0.83$). Similarly, the time when the female students consumed their largest amount of the diet ($p = 0.31$) did not turn out to be a significant factor related to the amount of body fat.

Since the results of the H-test identified the variables that could contribute to a major increase in body fat, in the further we focused on these particular variables. Table 3 shows the arithmetic mean and median of fat percentage in the female students divided into groups according their responses to the question on the frequency of food consumption. In Table 3 we can follow the decline in fat percentage of respondents with increasing frequency. The only exception is the "once a day" answer group, though represented by only one student. It follows that the frequency of diet can have a significantly interconnection with the amount of body fat.

Table 2 Statistical significance of differences in the percentage of fat between groups formed according the answers to particular questions (H-test).

Variables	H test	Probabilities
Frequency of food intake versus % fat	13.24	0.02
Breakfast versus % fat	0.88	0.83
Dinner versus % fat	32.26	0
Dinner hour versus % fat	62.54	0
Amount of food versus % fat	6.01	0.31

Table 3 Body fat percentage in groups formed according answers to question 1 - Frequency of eating.

Frequency	n	% fat	Median	Lower quartil	Upper quartil	SD
Once a day	1	21.3	21.3	21.3	21.3	
2-times a day	45	28.6	28.7	20.0	34.8	10.1
3-times a day	221	28.4	28.3	23.1	33.7	9.2
4-times a day	194	26.6	26.6	20.4	32.8	8.9
5-times a day	142	25.7	25.8	19.2	31.9	9.7
6-times a day	17	22.4	25.7	17.1	27.8	8.3

Legend: n - number, Lower - lower limit interquartile range, upper - upper limit interquartile range, SD - standard deviation; Applies to Tab. 3, 5, 7 **Frequency** - How many times a day do you eat? a) Once b) 2-times c) 3-times d) 4-times e) 5-times, f) 6-times or more.

Table 4 Differences in the percentage of body fat between groups formed according their answers to question 1 - Frequency (U-test)

Frequency	Rank Sum	Rank Sum	U	Z	p	Z adjusted	P adjusted	n	n	p 2*1sided
2x- 3x	6141.5	29369.5	4838.5	0.284	0.777	0.284	0.777	45	221	
2x- 4x	5916.5	22763.5	3848.5	1.235	0.217	1.235	0.217	45	194	
2x- 5x	4832.5	12745.5	2592.5	1.903	0.057	1.903	0.057	45	142	
2x- 6x	1558.0	395.0	242.0	2.209	0.027	2.209	0.027	45	17	0.026
3x- 4x	48181.5	38138.5	19223.5	1.815	0.070	1.815	0.070	221	194	
3x- 5x	42811.0	23255.0	13102.0	2.653	0.008	2.653	0.008	221	142	
3x- 6x	27040.0	1401.0	1248.0	2.303	0.021	2.303	0.021	221	17	0.020
4x- 5x	33584.0	23032.0	12879.0	1.017	0.309	1.017	0.309	194	142	
4x- 6x	20964.0	1402.0	1249.0	1.655	0.098	1.655	0.098	194	17	0.098
5x- 6x	11588.0	1132.0	979.0	1.268	0.205	1.268	0.205	142	17	0.207

Legend: 1 to 6-times - frequency of eating, RankSum - sum of sequences for every group, U - Mann-Whitney Test characteristics, Z - standardized U characteristics for n>20, p-probability of error for the respective characteristics (values lower than 0.05 are statistically significant), Z adjusted - adjusted Z value for the case of identical sequence, n - number, p 2 * 1sided - probability of error for small groups. Frequency - How many times a day do you eat? a) once b) 2-times c) 3-times d) 4-times e) 5-times, f) 6-times or more.

The H-test revealed statistically significant differences in the percentage of body fat between groups of students, but says nothing about the significance of differences between particular groups. Given the fact that the data are processed on a points scale, to detect differences between specific groups constituted on the basis of respondents' answers we applied a non-parametric Mann-Whitney test. In the question of meals frequency (Table 4), the Mann-Whitney test revealed statistically significant differences between group 2, eating 2-times a day, and group 6, reporting eating 6 or more times a day (p = 0.027). Similarly, we found significant differences between group 3, eating 3-times a day, and group 5 with 5 meals a day (p

= 0.008). A statistically significant difference was found between groups 3 and 6, that is between female students having meals 3-times and 6-times a day ($p = 0.021$). Among other groups, we found no statistically significant differences, which may be due to insufficient minor differences in body fat percentage between the groups or a small number of respondents in the groups.

The results of our research show that the frequency of meals is correlated with body fat, and is probably a highly significant factor influencing the amount of body fat. Based on this study, we recommend a frequency of 5 to 6-meals a day to maintain optimal body fat. Table 5 gives an overview of the arithmetic mean and median of student groups according their answer to question 2: "Do you have dinner every day"? The table shows a large difference in body fat between the group that regularly dines compared to the other groups who dine irregularly. The above variable could therefore prove a correlation between the regularity of meals and body fat percentage. The mode (most frequent figure) of body fat percentage in the group that dines regularly was 3.8% (mostly not) to 4.65% (mostly yes) lower compared with groups that eat irregularly. The mode of lowest body fat percentage (24%) was found in the "not having dinner"-group. This group, however, consisted of only 21 female students, and again this may point to a certain frequency, in terms of eating habits. The arithmetic mean of the body fat percentage of the group is but higher than in the group dining regularly.

The result of Mann - Whitney U-test (Table 6) shows statistically significant differences between the group that dines regularly (group 4) and groups that dine irregularly (groups 3 and 2). Among other groups we revealed no statistically significant differences. It follows that regular dinner and regular frequency within the diet can equally contribute to lower body fat.

Table 7 presents the arithmetic mean and median of students assigned to groups according to their answers to the question "When having dinner how long before bedtime is it." The lowest median (22.1%) was observed in the group dining 1 hour before bedtime. The table shows growing body fat percentage with prolonging the time of last meal. This holds for both, the arithmetic mean and for the median. The highest median percent body fat (29.8%) was observed in females who dine 4 hours or more before bedtime. The second highest median (28.4%) and arithmetic mean (29%) were recorded in female students who do not have dinner at all. Statistically significant differences (Table 8) were recorded between the group having its last meal 1hour before bedtime (group 2), the groups consuming the last meal 3 hours before going to bed (group 4), and 4 or more hours before bedtime (group 5), and the "no dinner" group (group 1). The same significant differences were seen also in the group dining 2 hours before going to bed (group 3). Based on this information, we do not recommend to eat the last meal of the day more than 2 hours before bedtime, while the best time of the last meal, according to our research, appears to be one hour before bedtime.

Table 5 Body fat percentage in the groups according to the answers to question 3 - Dinner

Dinner	Valid n	Mean X	Median	Lower	Upper	SD
Yes (group 4)	264	24.7	25.0	18.2	31.1	8.73
Mostly yes (group 3)	270	29.1	29.6	23.4	33.9	9.36
Mostly no (group 2)	65	28.7	28.8	22.3	34.9	9.61
No (group 1)	21	27.3	24.0	22.1	28.9	8.71

Legend: n - number, Lower - lower limit interquartile range, Upper - upper limit interquartile range, SD - Standard deviation. Dinner - Do you have dinner every day? yes b) mostly yes c) mostly not d) no.

Table 6 Differences in the percentage of body fat between groups according to answers in question 3 - Dinner (U-test).

Večera	Rank Sum	Rank Sum	U	Z	P	Z adjusted	P adjusted	n	n	p 2*1sided
4 - 3	60870.5	81974.5	25890.50	-5.469	0.000	-5.469	0.000	264	270	
4 - 2	41435.0	12850.0	6455.000	-3.093	0.002	-3.093	0.002	264	65	
4 - 1	37498.5	3256.5	2518.500	-0.696	0.486	-0.696	0.486	264	21	
3 - 2	45456.5	10823.5	8678.500	0.137	0.891	0.137	0.891	270	65	
3 - 1	39962.0	2524.0	2293.000	1.458	0.145	1.458	0.145	270	21	
2 - 1	2941.5	799.5	568.5000	1.141	0.254	1.141	0.254	65	21	0.254

1 - group answering No, 2 - group answering Mostly not, 3 - group answering Mostly yes, 4 - group answering Yes. **Dinner** - Do you have dinner every day? a) Yes b) Mostly yes b) Mostly not d) No. Other parameters the same like Tab. 4.

Table 7 Body fat percentage in groups formed according to the answers to question 4 - Dinner hour

Dinner hour	Valid n	Mean (%)	Median	Lower	Upper	SD
No dinner (group 1)	19	29.1	28.4	22.1	36.0	9.2
1 hour (group 2)	65	22.2	22.1	15.8	27.6	7.7
2 hrs (group 3)	174	24.1	23.8	17.4	30.3	8.7
3 hrs (group 4)	229	28.6	29.5	22.7	33.5	9.56
4 hrs (group 5)	132	30.4	29.8	24.9	34.7	8.35

Hour - Dinner hour before bedtime, n - number, Lower - lower limit quartile range, Upper - upper limit quartile range, SD - Standard deviation, Dinner hour - When having dinner, is it before bedtime mostly: a) Do not have dinner b) 1hour c) 2hrs d) 3hrs e) 4hrs and more.

Table 8 Differences in the percentage of body fat between groups formed based on their answers to question 4 - Dinner hour (U-test)

Večera hod	Rank Sum	Rank Sum	U	Z	p	Z adjusted	p adjusted	n	n	p 2*1sided
1 - 2	1057.5	2512.5	367.5	2.668	0.008	2.668	0.008	19	65	0.007
1 - 3	2287.5	16433.5	1208.5	1.921	0.055	1.921	0.055	19	174	0.054
1 - 4	2318.5	28557.5	2128.5	-0.155	0.877	-0.155	0.877	19	229	0.877
1 - 5	1269.0	10207.0	1079.0	-0.979	0.328	-0.979	0.328	19	132	0.330
2 - 3	7090.0	21590.0	4945.0	-1.492	0.136	-1.492	0.136	65	174	
2 - 4	6489.5	36875.5	4344.5	-5.121	0.000	-5.121	0.000	65	229	
2 - 5	4180.0	15323.0	2035.0	-5.992	0.000	-5.992	0.000	65	132	
3 - 4	29533.0	51873.0	14308.0	-4.848	0.000	-4.848	0.000	174	229	
3 - 5	22134.0	24837.0	6909.0	-5.968	0.000	-5.968	0.000	174	132	
4 - 5	39763.0	25578.0	13428.0	-1.765	0.078	-1.765	0.078	229	132	

1 - "do not have dinner" response group, 2 - "1hr before bedtime" response group, 3 - "2hrs before bedtime" response group, 4 - "3hrs before bedtime" response group, 5 - "4or more hrs before bedtime" response group; RankSum - sum of sequences for each group, Other parameters the same like Tab. 4. Dinner hour - When having dinner, how long before bedtime is it mostly?: a) Do not have dinner b) 1hr c) 2hrs d) 3hrs e) 4hrs and more.

DISCUSSION

Based on the results of H-test, we can conclude that breakfast in our study does not appear a factor that could affect the amount of body fat ($p=0.8$). This is in contradiction with the general physiological knowledge according which breakfast triggers digestion, thereby accelerating metabolism. According to Schlund [13], breakfast comprises an important part of a slimming program. On the other hand, the authors Timlin et al. [14] highlight the importance of breakfast in reducing body fat, although they argue that further experimental research is needed to confirm a direct relationship between breakfast and body weight. In our view, the amount of body fat is a multifactorial phenomenon, where breakfast represents only one of the many factors affecting the amount of body fat. Due to the particular composition of dietary habits, this factor did not necessarily prove to be sufficient, as it could have been overshadowed by specific structure of the other factors characteristic for our study group.

In Table 3 we observed a decrease in body fat percentage with increasing frequency. This correlation may indicate the impact of eating frequency on body fat, which is consistent with the findings of Toschke et al. [15], who also found a reduction of body fat with increasing frequency of meals in children. We recorded a significant jump in the percentage of body fat (Table 3) between the frequency of eating 3 or less times compared to a meals frequency of 4 or more a day. This conforms with the findings of Ma et al. [16], who found a lower risk of obesity in groups that ate 4 or more meals a day compared to groups having meals 3-times or less. The results of our research are thus consistent with those of other authors stating that the frequency of eating is likely to be a significant factor influencing the amount of body fat. Therefore, for optimal values of body fat we advise to have a meal 5 to 6-times a day.

In Table 5, providing information on the arithmetic mean and median in the groups of students divided by their answers to the second question: "Do you have dinner every day?", we observed high difference in body fat between the group that regularly dines and other groups who dine irregularly. The mode figure of body fat percentage in the group that regularly dines was 3.8% (mostly not) to 4.65% (mostly yes) lower compared with groups that eat irregularly. This variable may therefore indicate the overall frequency of meals rather than just the regularity of dinner. The results, in terms of the latter variable, are likely to show a correlation between the regularity of eating and body fat percentage. This is in line with the findings by Nicklas et al. [17], who also found an increased amount of body fat in people who eat irregularly, i.e. omit certain meals from their dietary regime. In this respect, regularity probably indicates a certain discipline in eating habits.

In our research we observed that the time of the last meal should be set no later than two hours before going to bed, with the optimal time of one hour before bedtime. The above findings are in line with our recommendations to have 5 to 6-meals a day. At a frequency of 6 meals a day, a relatively small amount of food is consumed within one meal, and the body is set to consume calories approximately every 2.5 hours. When multiplying 2.5×6 , we get the time interval from breakfast to dinner, namely 15 hours. Add to this an hour before bedtime and eight hours of sleep, it makes up the 24 hours of a day. At a frequency of 5 to 6 meals a day, the last meal can not be consumed much earlier than 2 hours before going to bed. If the last meal is consumed 1 hour before bedtime, at a frequency of eating 6-times a day, sleep is not going to happen with an empty stomach, and neither will one fall asleep overfed. Digestion of the food during sleep occurs during the first 1.5 hours, optionally can take a little longer due to lower energy requirements of the body. The rest of the night the body utilizes its stocks to support other body functions. The slower night metabolism is in the morning restarted by a

morning breakfast. A higher frequency of meals and shorter time between meals can thus maximize the work of organism through an accelerated mode of metabolism during the day, except sleeptime. Based on the results of U-test, we can conclude the following: Provided that the greatest amount of food is not consumed in the last meal, and the observed frequency of eating is 5 to 6-times a day, it is not advisable to consume the last meal more than 2 hours before bedtime, nor is it wise to avoid dinner at all. At a frequency of 6 meals a day, as mentioned above, the recommended optimal time of the last meal of day is one hour before bedtime.

CONCLUSION

The results of research demonstrate the importance of regularity of meals, as well as optimal frequency of eating, where the optimum recommended frequency is 5 to 6 meals a day. Our findings also show that dinner is inevitable. The last meal of the day should not be consumed later than 2 hours before bedtime, since a longer time without food slows the metabolism down. It reduces the amount of calories burned, leaving them a greater opportunity to be stored in the form of fat. No statistically significant differences were found between groups in terms of breakfast regularity. Despite the absence of statistically significant differences between the subgroups in our cohort, we tend to believe that breakfast constitutes a very important part of healthy diet, also in terms of obesity, as breakfast triggers the metabolism and the body begins burning more energy.

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Address for correspondence:

Rastislav Feč - University of P. J. Šafarik in Košice, Institute of Physical Education and Sport, Slovakia, email: rastislav.fec@upjs.sk

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