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Dietary habits in the context of body composition of young adult females

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ABSTRACT: Appropriate dietary habits and healthy nutrition play a part in weight control. Set positive principles make precondition for satisfactory state of the body and its composition. Body mass index (BMI) is most commonly used to assess optimal body mass in relation to health risks. However, BMI does not enable the representation of individual body components and may lead to misdiagnosis in one person. The aim of our study was to evaluate dietary habits and selected body composition parameters based on BMI. Moreover, we evaluated these parameters in relation to the daily frequency of meals. The research group consisted of 318 female students of pedagogical disciplines of Palacký University in Olomouc, aged between 18 and 30 years. (22.3±2.5 years). The survey was conducted in March 2018 and 2019. Data on dietary habits were acquired through a questionnaire survey that focused on the daily frequency of meals. Multi-frequency bioimpedance analysis using InBody 720 analyser was used to determine body composition parameters. In the normal weight BMI (BMI_N) category, the selected parameters (BFP: body fat percentage, VFA: visceral fat, FFM: fat-free mass) based on general recommendations for body composition are met. In the overweight and obesity (BMI_O) category, the mean BFP values fall, as expected, into the obesity category (≥ 35%). We may conclude that statistically significantly lower relative risk of damage to health assessed by the body fat and visceral fat (BFM, BFP, VFA, BFMI) was found to be significantly lower in women who consume 5 meals per day compared to women who consume 4 or less daily portions of food. The differences between the BMI categories for individual meals during the day were statistically insignificant for the group we investigated. We evaluate the dietary habits positively based on the low frequency of skipping meals.

KEY WORDS: young adulthood, frequency of meals, body mass index, somatic investigation

Introduction

Health is determined by many endogenous and exogenous factors. The most dominant factor, however, is the everyday lifestyle, which may build up the natural determining health factors and delay the onset or manifestation of many health and lifestyle related problems. Appropriate dietary habits create a precondition for the prevention of many chronic non-infectious diseases. Education in the areas of lifestyle, especially learning optimal eating habits, is a part of general

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and profiling disciplines of students of pedagogical disciplines (Andersen 2003; Katzmarzyk et al. 2008; Machová and Kubátová, 2010).

Rokyta (2000) states that even energy intake during the day maintains increased metabolic turnover rate and prevents the accumulation of reserves in the body. Regular food intake during the day is considered as a nutritional factor that is independent predictor of balanced weight. In addition to the appropriate amount of energy received, it is important to distribute it to more meals during the day. The energy received should be distributed into five servings (three main meals and two snacks). In general, it is recommended to prefer lower energy and lower glycaemic index foods in the afternoon (Ma 2003).

The body mass index (BMI) was recommended to be used to determine the optimal body mass. The advantage of BMI lies in its simplicity and its use in wide-ranging epidemiological research (Hainer et al. 2011; WHO 2004). Many authors do not consider the assessment by using BMI categorisation of body mass as satisfactory (Gába and Přidalová 2014; Kyle et al. 2004; Romero-Corral et al. 2008). BMI does not enable the representation of individual body components, principally body fat. Facts relating to the human body composition are the prerequisite for understanding its functioning in health and sickness. Body composition is a suitable indicator of the functional state of the organism and its fitness. Body composition is genetically influenced; it is further shaped by exogenous factors, including nutritional factors (Baumgartner 2000; Sofková and Přidalová 2015).

Appropriate indicators for conclusive evidence of somatic condition are individual body components, above all body fat (BFP, health recommendations at ≤ 35%), fat-free mass (FFM) and health indicators relating to body composition, e.g. body fat mass index (BFMI, range within 3.9 kg/m^2 to 8.1 kg/m^2 corresponds to the health recommendation for women) and fat-free mass index (FFMI, range within 14.6 kg/m^2 to 16.7 kg/m^2 corresponds to the health recommendation for women) (Heyward and Wagner, 2004; Kyle et al. 2004).

The objective of our study was to evaluate dietary habits and selected parameters of body composition based on BMI and to evaluate these parameters based on the daily frequency of meals in 318 female students of the Pedagogical Faculty of Palacký University in Olomouc.

Material and Methods

Research group

The research group consisted of 318 randomly selected female students of teaching programs at the Pedagogical Faculty of Palacký University in Olomouc within the age range of 18–30 years (22.3±2.5 years). Namely, 1st and 3rd years of the bachelor level course graduating in Physical Anthropology (full-time attendance or combined study). 17 underweight female students who underwent somatic measurements were excluded from further research.

Standardised anthropometric methods for determination of basic somatic parameters and somatic indices were used in the investigation. Body mass index (BMI = body mass/body height^2, kg/m^2) was used to evaluate body mass categorisation. Students were divided into two groups based on the categorisation of BMI (BMI_N – normal mass: 18.5 to

24.9 kg/m^2, n=242; BMI_O – overweight and obesity: ≥ 25.0 kg/m^2, n=76). Body height was determined with an accuracy of 0.5 cm by P-226 anthropometer (Trystom, Czech Republic). Body mass was determined using InBody 720 analyser. The average BMI of the normal mass category (BMI_N) was 21.4±2.1 kg/m^2. The mean body height was 166.7±6.4 cm and the mean body mass was 59.2±7.4 kg. The average BMI of the overweight and obesity category (BMI_O) was 30.2±2.5 kg/m^2, the mean body height was 167.3±6.3 cm and the average body mass was 85.1±18.6 kg. Furthermore, we evaluated selected somatic characteristics based on the recommended daily frequency of meal: Group I (5 meals per day or more, n=218) and Group II (4 meals per day or less, n=100).

Research part of the project was carried out during February 2018 and 2019. Each female student signed a written consent to the measurement and was familiarised with the organisational requirements of the research. The project was approved by the Ethics Committee of the Faculty of Education, Palacký University Olomouc, under no. 09/2018.

Evaluation of body composition

InBody 720 analyser was used to diagnose body composition by direct-controlled multi-frequency bioelectric impedance (1–1000 kHz). The principle of the bioelectric impedance method is based on the differences in the propagation of high-frequency alternating current of different intensity in different biological structures. It is a non-invasive and time-saving method. The device differentiates body mass into three components, namely the total body water (intracellular and extracellular water), the dry matter (proteins and minerals) and the body fat. InBody 720 also analyses the amount of visceral fat that is defined as the transversal cross-sectional area in the abdominal region at vertebrae L4-L5. The correlation between Computed Tomography and InBody 720 methods is defined at r = 0.92 level (Biospace 2008). Measurements were carried out under standard conditions given by the device manual (Biospace, Seoul, South Korea). Before each measurement, female students were acquainted with the guidelines that are required to acquire valid body composition information.

Questionnaire survey relating to dietary habits

Data relating to dietary habits was acquired through an investigation that focused on the frequency of daily food consumption (breakfast, snack in the morning, lunch, afternoon snack, dinner). Based on the recommendations in the "Nutritional Recommendations for the Population of the Czech Republic" (2012) paper, the optimal diet was determined as having five meals over the course of the day and non-optimal diet as having four or less daily portions of food (SPV, 2012).

Data analysis

Collected body composition data was processed using Lookin'Body 3.0 program. Data relating to dietary habits were transferred to MS Excel spreadsheet. Statistical data analysis was carried out with the use of through Statistica 10.0 program (StatSoft, Tulsa, USA). The polynomial regression method was used to determine the relationship between BMI and body fat percentage (BFP, %). Key

statistical quantities for the monitored parameters (somatic characteristics) and their differences between BMI categories were calculated (BMI_N, BMI_O). The basic statistical variables for the monitored parameters (somatic characteristics) and their differences between the groups (Group I, Group II) were calculated. The significance of these differences was tested using the Mann-Whitney U test. The significance of daily foot consumption between BMI categories was tested using the Test for comparing relative frequency. Statistical significance was determined at $\alpha<0.05$ level.

Results

The target group were female students, within the age range of 18–30 years (22.3±2.5 years), of the Pedagogical Faculty of Palacký University in Olomouc. Future educators were divided into two groups according to the body mass index categorisation (BMI_N – normal mass, n = 242; BMI_O – overweight and obesity, n = 76). The research included somatic examination and questionnaire survey relating to dietary habits.

Frequency of daily food consumption (breakfast, snack in the morning, lunch, afternoon snack, dinner) is presented in Table 1. In the BMI_N category, 80.6% of female students regularly eat breakfast and 76.3% in the BMI_O category. 24.3% in BMI_N category and 22.3% in BMI_O category eat breakfast within half an hour of awakening. The morning snack is regularly consumed by 92.9% of female students in the BMI_N category and 85.5% in the BMI_O category ($p=0.04$). 67.7% in the BMI_N category and 59.2% in the BMI_O category from the monitored group regularly eat lunch. Up to 98% of female students in both categories regularly snack in the afternoon. Usually, female students have a dinner, in the BMI_N category 74.7% and 72.3% of students in the BMI_O category. Based on the low frequency of skipping meals, we evaluate the dietary habits positively.

Table 2 presents selected somatic characteristics of the body composition for each group differentiated according to the BMI categories. Looking at BMI categories, it is apparent that the average percentage of body fat corresponds to the normal weight category (BFP_{BMI_N}: 25.9%). The average body fat values in BMI overweight and obesity category (BFP_{BMI_O}: 39.9%) fall into the obesity category. In the case of visceral fat (VFA, cm^2), the recommended standard (>100 cm^2) is exceeded in the BMI_O category (VFA_{BMI_N}: 42.9 cm^2; VFA_{BMI_O}: 112.2 cm^2, $p<0.001$). Higher relative representation of the average skeletal-muscle mass (SMM, kg) was of the total body mass (BM, kg) recorded for BMI_N (skeletal-muscle percentage $_{BMI\_N}$: 69.4%; skel-

Table 1 Frequency of daily food consumption in relation to the BMI

Variable	BMI normal (n=242)		BMI overweight and obesity (n=76)		*p*-value
	n	%	n	%	
Breakfast	195	80.6	58	76.3	0.41
Snack morning	225	92.9	65	85.5	0.04
Lunch	164	67.7	45	59.2	0.17
Snack afternoon	238	98.3	74	97.3	0.58
Dinner	181	74.7	55	72.3	0.67

Table 2. Selected body composition characteristics in relation to the BMI

Variable	BMI normal (n=242) Mean±SD	BMI overweight and obesity (n=76) Mean±SD	*p*-value
BFP (%)	25.9±5.4	39.9±4.1	<0.001
BFM (kg)	15.5±4.2	34.5±6.3	<0.001
VFA (cm²)	42.9±15.5	112.2±22.1	<0.001
TBW (%)	54.2±4.0	43.8±2.9	<0.001
TBW (l)	32.0±3.3	36.8±3.8	<0.001
FFM (kg)	43.7±4.5	50.3±5.2	<0.001
SMM(kg)	41.1±4.2	47.3±4.9	<0.001
BMI (kg/m²)	21.4±1.8	30.2±2.2	<0.001
BFMI (kg/m²)	5.6±2.3	12.4±3.5	<0.001
FFMI (kg/m²)	15.9±2.9	18.1±2.4	<0.001

Note: BFP – Body Fat Percentage; BFM – Body Fat Mass, VFA – Visceral Fat Area, TBW – Total Body Water, FFM – Fat-free Mass, SMM – Skeletal Muscle Mass, BMI – Body Mass Index, BFMI – Body Fat Mass Index, FFMI – Fat-free Mass Index.

etal-muscle percentage $_{BMI\_O}$: 55.5%). Percentage of total body water (TBW, %) in the BMI_O category (TBW_{BMI_O}: 43.8%) did not exceed 50%. BFMI (body fat mass index) for the BMI_O category indicates high risk of obesity. Average BFMI for the BMI_N category was significantly lower than for the BMI_O category ($BFMI_{BMI\_N}$: 5.6 kg/cm²; $BFMI_{BMI\_O}$: 12.4 kg/cm², $p<0.001$). Average fat-free mass index in the BMI_N category ($FFMI_{BMI\_N}$: 15.9 kg/cm² corresponds the health recommendation for women, which is within the range of 14.6 kg/m² to 16.7 kg/m²).

The polynomial regression modelling was carried out with the aid of Statistica 10.0 program, namely dependency of BMI on BFP. The following equation was derived by observing the relationship between BMI (kg/m²) and BFP (%): $BMI = 22.4067 - 0.4252(BFP) + 0.0145(BFP)^2$. Figure 1 shows a graphical representation of the relationship, namely the regression curve together with the prediction interval. The coefficient of determination of this model is 0.86.

We have also divided the monitored students into two groups that meet and do not meet the recommended frequency of daily meals (Group I – 5 meals per day or more, n=218; Group II – 4 meals per day or less, n=100). Table 3 presents selected somatic characteristics of the body composition for each group differentiated according to the daily frequency of meals. Among the groups of women with different frequency of daily meals, there are statistically significant differences in

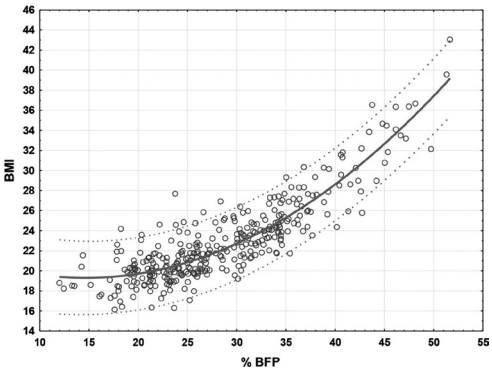

Fig. 1. Relationship between body mass index and body fat percentage

the parameter associated with risk aspects of obesity, namely in the body fat (BFM_{kg}: p = 0.01, $BFP_{\%}$: p = 0.005). A group of women with a frequency of 5 or more meals per day (Group I) has the percentage of fat BFP = 26.3%. Proportion of relative body fat in the group with daily meals less than 5 (Group II) exceeds the recommended 28% ($BFP_{Group\ II}$: 29.3%).The relative TBW was of the total body mass (BM, kg) in $TBW_{Group\ I}$: 53.3% and in $TBW_{Group\ II}$: 50.9%. Average BMI values are in the normal weight category only for the 5 and more meals per day group ($BMI_{Group\ I}$: 23.2 kg/m²). Average BFMI values fall within the health-safe range and there are statistically significant differences between the two groups ($BFMI_{Group\ I}$: 6.3 kg/m²; $BFMI_{Group\ II}$: 15.2 kg/m², p=0.008). Average FFMI corresponds to higher muscle mass development ($FFMI_{Group\ I}$ = 16.8 kg/m²; $FFMI_{Group\ II}$ = 18.9 kg/m², p=0.39).

Table 3. Selected body composition characteristics in relation to the dietary habits

Variable	Group 1 n=218 Mean±SD	Group 2 n=100 Mean±SD	*p*-value
BFP (%)	26.3±8.6	29.3±8.6	0.005
BFM (kg)	17.8±8.8	20.7±10.5	0.01
VFA (cm²)	58.3±34.5	67.4±42.1	0.11
TBW (%)	53.3±4.2	50.9±4.7	0.22
TBW (l)	35.4±6.7	34.5±6.4	0.26
FFM (kg)	48.4±9.2	47.1±8.7	0.26
SMM(kg)	45.5±8.7	44.3±8.2	0.25
BMI (kg/m²)	23.2±4.0	34.4±4.3	0.29
BFMI (kg/m²)	6.3±3.1	15.2±5.1	0.008
FFMI (kg/m²)	16.8±2.0	18.9±1.9	0.39

Note: Group_I (II) – categorisation of daily frequency of meal (Group I – 5 meals per day or more, Group II – 4 meals per day or less); BFP – Body Fat Percentage, BFM – Body Fat Mass, VFA – Visceral Fat Area, TBW – Total Body Water, FFM – Fat-free Mass, SMM – Skeletal Muscle Mass, BMI – Body Mass Index, BFMI – Body Fat Mass Index, FFMI – Fat-free Mass Index.

Discussion

Appropriate dietary habits are one of the important preconditions for a healthy lifestyle. Meals should be eaten regularly and at regular times. Breakfast is the meal with the greatest metabolic effect and the relationship to maintaining acceptable weight. This relationship has been demonstrated in adults in the study by Timlin, Pereira, Story and Neumark-Sztainer (2008). Of the total number of women monitored, 77.5% eat breakfast regularly. The differences between the BMI categories for individual meals during the day were statistically insignificant for the group we investigated. Individual portions of BMI_O students with their size and caloric intake may exceed the recommended amount of food. We did not study this variable (size and caloric intake of food). In relation to our findings, with similar frequency of daily meals in individual BMI categories, the reasons of overweight and obesity among students might be also related to other issues.

The World Health Organization (2004) names the indirect fundamental causes of obesity the increasing urbanisation, industrialisation and disappearance of traditional lifestyles with direct factors being sedentary lifestyle and high-energy diet. Lack of regular physical activity is also associated with increased obesity which has major impact on human health. Our health is also negatively influenced by deterioration of environmental conditions and higher psychological stress, both typical in today's modern times (Doll et al. 2000; Hoeger and Heger 2009).

Even energy intake during the day prevents storage of reserves in the body and is an independent predictor of ap-

propriate weight (Ma, 2003). Kant and Schatzkin (1995) state, that there is inverse relationship between the BMI and the frequency of food consumed in adults. In addition to the appropriate amount of energy received, it is important to distribute it to more meals during the day shared out into five portions. Based on our findings, differently to previous research, where statistically lower differences only in body fat values (BFM, BFP, BFMI) were found in individuals who consume at least five portions per day. In our study groups with different frequency of meals did not significant differ in BMI. Gába and Přidalová (2014) report that increased body fat may not always be accompanied by higher body mass.

Body composition is a reflection of lifestyle. Knowledge of the composition of the human body is a prerequisite for understanding its functioning in health and disease. Given the fact that the bioelectric impedance is the standard method used in research worldwide, it is the most advantageous and widely used method. Recently, there has been a growing interest in information in relation to body composition, particularly in relation to the increase in the number of overweight and obese individuals.

Body fat is the most variable component of body mass and is a major factor in body composition variability and is easily influenced by dietary habits. Based on Heyward and Wagner's average BFP (2004), women with BMI_O were classified as obese (> 35%). The relationship between the fat-free mass (FFM, kg) and BFM relates to nutrition and physical activity and characterises the somatic condition of the individual very well. Fat-free mass (FFM) is also indicative of the amount of proteins and minerals in the body. The water content is low in obese people, with only 45% of body weight. In the BMI_O category, body water did not exceed 50% limit (TBW_{BMI_O}: 43.8%), which is consistent with the assumption that the body water is in reciprocal relation to body fat (Chumlea et al. 1999). Visceral fat value in the BMI_O category (VFA_{BMI_O}: 112.2 cm^2) determine abdominal obesity, which is one of the major criteria for metabolic syndrome. It has an almost comparable predictive value for severe cardiovascular events such as raised LDL cholesterol level (Ganong et al. 2005).

Conclusion

The differences between the BMI categories for individual meals during the day were statistically insignificant for the group we investigated. Of the total number of female students monitored, 3/4 students regularly eat breakfast and dinner. The morning snack is regularly consumed by 92.9% of students in the BMI_N category and 85.5% of students in the BMI_O category. 67.7% in the BMI_N category and in the BMI_O category 59.2% female students lunch regularly. Up to 98% of students in both categories regularly have the afternoon snack. The afternoon snack may probably replace lunch. The reasons of overweight and obesity among students might be also related to other issues in relation to similar frequency of daily meals in both BMI categories.

In the normal mass category (BMI_N), the recommended standards of average somatic characteristics were confirmed. In the BMI_O category, higher significant average values were confirmed for selected characteristics related to risk aspects of overweight and obesity (BFM: body fat mass, BFP: body fat percentage, VFA:

visceral fat, BFMI: body fat mass index). The average VFA value (>100 cm^2) in the BMI_O group indicated a possible moderate risk of cardiovascular disease and lipid spectrum changes. In addition, lower average body water, fat-free mass and skeletal-muscle mass (TBW, FFM, and SMM) were demonstrated in the BMI_O category.

Moreover, it has been shown that the energy received has, distributed into five portions per day, optimal effect on the body composition status. Statistically significantly lower body fat (BFM, BFP) values were found in women who consume at least five portions per day (Group I). The average body composition risk index values for obesity BFMI fall within the health safety zone (3.9–8.1 kg/m^2) in both groups, although Group I has statistically significantly lower values.

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Authors' contributions

All authors credited for having contributed equally to this research paper.

Conflict of interest

The authors declare that they have no conflicts of interest to this work.

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References

Andersen RE. 2003. Obesity. Etiology assessment treatment and prevention. Champaign: Human Kinetics.

Baumgartner RN. 2000. Body composition in Healthy Aging. Ann NY Acad Sci 904:437–48.

Doll HA, Petersen S, Stewart-Brown SL. 2000. Obesity and physical and emotional well-being: Associations between body mass index, chronic illness and the physical and mental compartments of the SF-36 questionnaire. Obesity Revue 8:160–70.

Gába A, Přidalová, M. 2014. Age-related changes in body composition in a sample of Czech women aged 18–89 years: a cross-sectional study. Eur J Nutr 53:167–76.

Ganong WF. 2005. Přehled lékařské fyziologie (Review of Medical Physiology). Praha: Galén. (in Czech).

Hainer V. 2011. Základy klinické obezitologie 2 (Basics of Clinical Obesitology 2). Praha: Grada Publishing, a. s. (in Czech).

Heyward VD, Wagner DR. 2004. Applied body composition assessment. Champaign, IL: Human Kinetics.

Hoeger WWK, Heger SA. 2009. Fitness and wellness. Belmont, CA: Wadsworth Cengage Learning.

Chumlea WC, Guo SS, Zeller CM, Reo NV, Siervogel RM. 1999. Total body water data for white adults 18 to 64 years of age: The Fels Longitudinal Study. Kidney International 56(1): 244–52.

Kant AK, Schatzkin A, Graubard BI, Ballard-Barbash R. 1995. Frequency of eating occasions and weight change in the NHANES I Epidemiologic Follow-up Study. Int J Obes Relat Metab Disord 19(7), 468–74.

Katzmarzyk PT, Baur LA, Blair SN, Lambert EV, Oppert JM, Riddoch C. 2008. Interna-

tional conference on physical activity and obesity in children: Summary statement and recommendations. Appl Physiol Nutr Me 33(2):371–88.

Kyle UG, Morabia A, Schutz Y, Pichard C. 2004. Sedentarism affects body fat mass index and fat-free mass index in adults aged 18 to 98 years. Nutrition 20(3):255–60.

Ma Y. 2003. Association between eating patterns and obesity in a free-living US adult population. Am J Epidemiol 158(1):85–92.

Machová J, Kubátová D. 2010. Výchova ke zdraví (Health education). Praha: Grada. (in Czech).

Rokyta R. 2000. Fyziologie pro bakalářská studia v medicíně, přírodovědných a tělovýchovných oborech (Physiology: for bachelor's studies of medicine, sciences and physical education). Praha: ISV. (in Czech).

Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, et al. 2008. Accuracy of body mass index in diagnosing obesity in the adult general population. Int J Obes 32:959–66.

Sofková T, Přidalová M. 2015. Somatic characteristics in relation to meeting recommended physical activity in overweight and obese women aged 30–60 years. Acta Gymnica 45(3):121–28.

Společnost pro výživu (The Czech Society for Nutrition) (SPV). 2012. Výživová doporučení pro obyvatelstvo České republiky (Nutritional Recommendations for the Population of the Czech Republic). Available at: http://www.vyzivaspol.cz/vyzivova-doporuceni-pro-obyvatelstvo-ceske-republiky/ (in Czech).

Timlin MT, Pereira MA, Story M, Neumark-Sztainer D. 2008. breakfast eating and weight change in a 5-year prospective analysis of adolescents: project EAT (Eating Among Teens). Pediatrics 121(3):638–45.

World Health Organization (WHO). (2004). *Global strategy on diet, physical activity and health. Geneva*: WHO.