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Somatic characteristics in relation to meeting recommended physical activity in overweight and obese women aged 30–60 years

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Background: Physical activity (PA) can provide health benefits and thus reduce the risk of complications from obesity and improve mental well-being. We consider body composition as an acceptable indicator of the functional condition of the body. **Aims:** Our research objective was to analyse selected body composition fractions in relation to meeting recommended PA in overweight and obese women. **Methods:** 221 women participated in our study, divided in two age groups: 30 to 44.9 years (Maturus I, n = 118) and 45 to 60 years (Maturus II, n = 103). Each age group was further differentiated by sub-groups (adequate and inadequate PA) according to the achieved PA level (medium PA: 3 to 6 MET; ≥ 150 min/week). To determine the PA parameters within one week the ActiGraph GT1M accelerometer was used. The InBody 720 body composition analyser was used to determine body composition parameters. Descriptive characteristics and data analysis were carried out using Statistica 10.0. Differences were compared by the Student's t-test. Statistical significance level was set at $\alpha < .05$. **Results:** Younger women who achieved adequate PA reached lower average values of body fat mass and visceral fat area than women with inadequate PA. Higher average values of the fat-free mass, body cell mass and skeletal muscle mass were found in older women with adequate PA in comparison with women with inadequate PA. **Conclusions:** The research study verified a positive relationship between meeting the recommended PA level and its impact on body composition health risk indicators. A positive approach to the PA may lead to a decrease in health problems associated with excess weight and obesity.

Keywords: obesity, healthy lifestyle, body composition, accelerometer

Introduction

The accelerated pace of natural life and consumerism result in an increase in obesity. Sedentary lifestyle and obesity are among the most discussed health topics across all society; they are usually associated with health problems. The WHO (2004) names the indirect fundamental causes of obesity as increasing urbanisation, industrialisation and disappearance of traditional lifestyles with direct factors of sedentary lifestyle and high-energy diets. Lack of regular physical activity (PA) 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, Petersen, & Stewart-Brown, 2000; Hoeger & Hoeger, 2009).

Sedentary lifestyle is associated with health problems and also becomes a psychological and social risk (Kalvach, Zadák, Jirák, Zavázalová, & Sucharda, 2004). PA is one way how to positively influence physical and mental health. Lack of PA and a preference to a sedentary lifestyle lead to fading physical condition which causes the elderly population premature loss of self-sufficiency and significantly impairs their quality of life. Varo et al. (2003) indicate that the prevalence of sedentary lifestyle in the EU is at a high level and with increasing age of the population the number of inactive people increases.

A decrease in the level of PA is significantly modified by exogenous factors which include obesity, smoking and the level of educational attainment. Obese individuals, smokers and people with secondary or university education have lower levels of PA (Norman, Bellocco, Vaida, & Wolk, 2002). The study by

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Ball, Crawford, and Owen (2000) reported that excess weight in women is a barrier to PA in 6.2% and in obese women 22.6%. Every year an increasing number of people are at risk of being overweight and obese and consequently there is a desire to find a natural way to encourage people to carry out key recommendations for implementing different types of PA. This should lead to improvement in the population's quality of life and result in significantly decreased health care costs related to the consequences of obesity.

Regular PA prevents obesity and it is a natural tool in reducing its prevalence as it relates to long-term maintenance of reduced body mass. It prevents the reduction of basal metabolic rate and restriction of fat-free mass. Regular PA promotes health and prevents the onset of a number of diseases, as well as improving social connectivity and quality of life (Andersen, 2003; Miles, 2007).

We consider the optimum body composition as an acceptable indicator of the functional condition of the body and its fitness. Good indicators of somatic condition are the body components, particularly fat and fat-free mass, and the body composition health indicators, such as the Body Fat Mass Index (BFMI), Fat-Free Mass Index (FFMI), Visceral Fat Area (VFA), Obesity Index (OI) and Body Cell Mass Index (BCMI). Long-term reduction in PA is reflected in inadequate representation of different body fractions and body composition health risk indicators (Heyward & Wagner, 2004; Kyle, Morabia, Schutz, & Pichard, 2004; Přidalová, Riegerová, Dostálová, & Gába, 2008).

A key indicator which determines whether the effect of PA is maintaining the achieved weight loss is the level of PA. This is determined by the intensity and duration of the given PA and frequency of exercise units. PA should be carried out by rhythmic contractions of large muscle groups. Recommendations of the American Association of Sports Medicine states that the optimum aerobic exercise of medium intensity (such as brisk walking, 3 to 6 MET) at least 30 minutes for five days a week (150 min/week) should be undertaken by people who wish to maintain good health. Equally, combination of medium and high intensity exercise with duration of 30 respective 20 minutes is suggested. Exercise time may be divided into several shorter sections; each exercise must be at least 10 minutes long (Haskell et al., 2007). Saris et al. (2003) recommends walking, at least 10,000 steps/day, to maintain desired weight. For prevention of obesity 30 minutes of medium activity per day and for the prevention of recurrence of weight increase in previously obese people 60 to 90 minutes per day is recommended. Reduction of body mass and obesity in the population may be successfully carried out on the basis of professional recommendations regarding the prescription of the appropriate PA (Jeffery, Wing, Sherwood, & Tate, 2003). Monitoring the PA to improve compliance with the recommended exercise regimen for overweight and obese women has been shown to have considerable influence and for the obese women is significantly motivating (Sofková, Přidalová, & Pelclová, 2014).

An analysis of body composition can be used as a predictor for assessment of current somatic conditions. Searching for associations between body composition and PA especially in the group of overweight and obese females is needed. Consequently, there is a desire to find natural way to encourage people to carry out key recommendations for implementing different types of PA.

Aim

Our research objective was to analyse selected body composition fractions in relation to meeting recommended seven day physical activity in overweight and obese women aged 30–60 years.

Methods

Researched groups included 221 overweight and obese women from the Olomouc region within the age range of 30 to 60 years. Women were divided into two groups according to age: 30 to 44.9 years (Maturus I, $n = 118$) and 45 to 60 years (Maturus II, $n = 103$). In the first group (Maturus I) the average age was 38.4 years (SD = 6.7) and in the second group (Maturus II) average age was 52.1 years ($SD = 5.3$). The age limit selection was based on literature review taking into account the onset of menopause (Cibula, Henzl, & Živný, 2002; Fanta, 2007; Riegerová, Přidalová, & Ulbrichová, 2006).

Seven day PA monitoring was carried out from 2011 to 2014, namely in January, April and September. Women were not briefed on the recommended level of PA in terms of the level and intensity within the weekly monitoring. For description in more detail, see below. Each age group was divided into two sub-groups (group with adequate PA and group with inadequate PA) according to the achieved PA level, either meeting or not meeting the recommended medium PA level in terms of intensity (PAme, 3 to 6 MET) and level ($\geq$ 150 min/week) (U.S. Department of Health and Human Services, 2008).

Each woman signed an agreement to carry out measurements and was introduced to the research particulars. Furthermore, the women were familiarised with the rules, as observance was essential to acquire valid data relating to body composition, instructed in accelerometer use and entry of data into the record sheet.

Measurement methods

Standardised anthropometric methods for the determination of key somatic parameters (body height, body weight) and somatic indices (Riegerová et al., 2006; WHO, 2004) were used in our investigation. For the assessment of excess weight and obesity the Body Mass Index (BMI) was used (normal mass: from 18.50 to 24.99 kg/m^2; overweight: 25.00 to 29.99 kg/m^2; obesity: 30.00 to 34.99 kg/m^2).

To diagnose body composition the InBody 720 body composition analyser (Biospace, Seoul, South Korea) using the direct multi-frequency bioelectrical impedance analysis method (DSM-BIA Method) was used. The principle of bioelectrical impedance method is based on differences in the propagation of high-frequency alternating electrical current of varying intensity in different biological structures. It is non-invasive and time saving method. The device differentiates body weight into three components – total body water (intracellular and extracellular fluid), dry matter (proteins and minerals) and body fat. The method is unified and measurement is carried out under standard conditions set by the device's instruction manual (Biospace, 2008). Prior to each measurement participants were familiarised with the rules, as observance was essential to acquire valid data relating to body composition.

One week monitoring of PA level and intensity and average daily number of steps was carried out using the ActiGraph GT1M (ActiGraph, Pensacola, FL, USA) accelerometer together with data entry into the record sheet. Women were instructed that the device must be worn at least 10 hours a day for seven days and only taken off for sleep or water related activities (swimming, hygiene). Seven day PA monitoring is considered sufficiently reliable in adults (Murphy, 2009; Trost, McIver, & Pate, 2005).

Data processing

Data acquired by the InBody 720 Body Composition Analyser were processed using standard procedures using the LookinBody 3.0 software package (Biospace, Seoul, South Korea). Data measured by the ActiGraph GT1M were processed using software ActiPA 2006 (SoftWare Centrum, Olomouc, Czech Republic).

Descriptive characteristics and data analysis were carried out using the Statistica (Version 10; StatSoft, Tulsa, OK, USA). Differences in body composition between groups with various levels of PA were observed by Student's t-test. Statistical significance level was set at $p < .05$.

Results

In active women we recorded the average daily number of steps (HPA) to be as per recommended level (HPA, 10,000 steps/day) (Table 1). Average daily active energy expenditure (AEV, kcal) was greater in younger women, as well as the moderate PA (PAmo, 1 to 2.99 MET) and medium PA (PAme, 3 to 6 MET). Assessment of PA suggests that older women achieved general recommendation relating to medium PA (3 to 6 MET) better. Measurement results showed that the younger active women achieved average value of 289 min/week and older active women 299 min/week. Younger inactive women reached average of 97 min/week and older women 87 min/week (Figure 1).

Selected somatic characteristics differentiated by the group with adequate PA and group with inadequate PA are presented in Table 2. Total body water (TBW, l) did not exceed the 50% threshold in any of the subgroups which corresponds to the assumption that the amount of TBW is in the reciprocal relationship to

Table1

Differences analysis of selected physical activity indicators

	Maturus I (n = 118)		Maturus II (n = 103)	
	Adequate PA	Inadequate PA	Adequate PA	Inadequate PA
PAmo (min)	73.3 ± 29.6	64.3 ± 26.2	70.4 ± 29.5	60.3 ± 24.7
PAme (min)	41.3 ± 16.7	13.8 ± 4.4*	42.7 ± 17.7	12.4 ± 5.9*
AEV (kcal)	691.2 ± 253.5	508.4 ± 319.2*	609.3 ± 199.1	406.3 ± 160.8*
HPA (step)	10,586 ± 2,809	7,283 ± 2,159*	10,827 ± 2,662	6,964 ± 1,508*

Note. PA = physical activity, PAmo = moderate PA (1 to 2.99 MET), PAme = medium PA (3 to 6 MET), AEV = average daily active energy expenditure, HPA = average daily number of steps. Values are given as $M \pm SD$. *statistically significant difference between women with adequate and inadequate PA ($p < .05$).

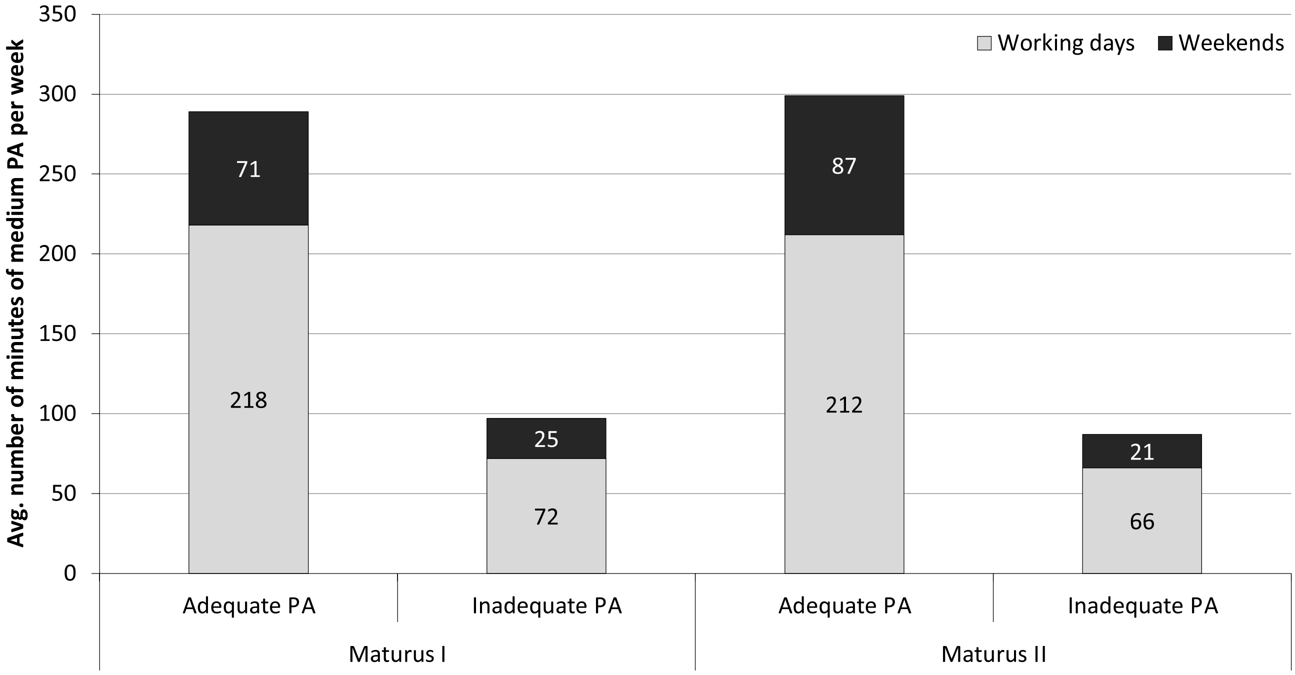

Figure 1. Comparison of weekly medium PA (3 to 6 MET) in women groups

Table 2
Selected somatic characteristics in relation to the age and physical activity

	Maturus I (n = 118)		Maturus II (n = 103)	
	Adequate PA	Inadequate PA	Adequate PA	Inadequate PA
Height (cm)	166.7 ± 6.9	166.5 ± 9.5	160.6 ± 7.7	163.8 ± 7.9
Weight (kg)	88.1 ± 15.1	95.2 ± 18.1*	84.4 ± 11.8	90.5 ± 13.5*
TBW (l)	37.7 ± 4.8	39.1 ± 4.9	35.3 ± 4.1	37.8 ± 4.2*
ECW (l)	14.3 ± 1.8	14.8 ± 1.9	13.5 ± 1.5	14.5 ± 1.7*
ICW (l)	23.4 ± 3.1	24.1 ± 3.1	21.8 ± 2.5	23.3 ± 2.5*
FFM (kg)	51.5 ± 6.6	53.3 ± 6.6	48.2 ± 5.5	51.5 ± 5.8*
FFP (%)	58.9 ± 5.5	56.8 ± 6.5	57.4 ± 4.9	57.4 ± 5.7
BFM (kg)	36.5 ± 10.2	41.9 ± 13.5*	36.2 ± 8.3	39.1 ± 10.4
BFP (%)	40.9 ± 5.5	43.2 ± 6.4	42.5 ± 4.9	42.5 ± 5.7
BCM (kg)	33.5 ± 4.3	34.6 ± 4.3	31.2 ± 3.6	33.4 ± 3.7*
SMM (kg)	28.5 ± 3.9	29.5 ± 3.9	26.4 ± 3.3	28.4 ± 3.3*
VFA (cm^2)	138.1 ± 38.7	156.5 ± 48.9*	155.1 ± 28.2	162.7 ± 38.9

Note. PA = physical activity, TBW = Total Body Water, ECW = Extracellular Body Water, ICW = Intracellular Body Water, FFM = Fat-free Mass, FFP = Fat-free Percentage, BFM = Body Fat Mass, BFP = Body Fat Percentage, BCM = Body Cell Mass, SMM = Skeletal Muscle Mass, VFA = Visceral Fat Area. Values are given as M ± SD. *statistically significant difference between women with adequate and inadequate PA ($p < .05$).

body fat. In body composition health indicators we observed significant health risks, namely exceeding the threshold limit.

Representation of the BFM (Body Fat Mass, kg) was very high, exceeding 35 kg, and the relative value of the BFP (Body Fat Percentage, %) reached 40%. In older women with inadequate PA we observed higher values of the VFA, which greatly exceeded the recommended value (> 100 cm^2). Younger and also older women who achieved adequate PA reached lower average values of monitored parameters, i.e. the fat fraction (BFM, BFP) and also VFA. In younger women we found statistically significant differences in parameters associated with the risk aspects of obesity, specifically in body weight (kg), BFM and VFA. In older women with adequate PA we found statistically significant differences in the TBW, FFM (Fat-free Mass, kg), BCM (Body Cell Mass, kg) and in SMM (Skeletal Muscle Mass, kg). A higher value of relative Fat-free Mass (FFP: Fat-free Percentage, %) and lower value of BFP was found in younger active women, than in women with inadequate PA, however the differences were not statistically significant.

The relative risk of damage to health, as measured by the BMI, was high (Table 3). The average BMI values were within the obesity category (BMI ≥ 30 kg/m^2). BMI does not cover variability and changes in BFM and FFM. For more objective assessment of the relative risk of damage to health the BFMI and FFMI were used. BMI ≥ 30 kg/m^2 classification is set to be equivalent to the BFMI ≥ 11.8 kg/m^2 and FFMI ≥ 18.2 kg/m^2, which does correspond to our results (Schutz, Kyle, & Pichard, 2002; Kyle et al., 2004). The index of metabolically active cells (BCMI, Body Cell Mass Index; 11.90 to 12.31 kg/m^2) corresponds to the health recommendations for women (Talluri et al., 2003).

Discussion

One aspect of the increasing prevalence of excess weight and obesity is widespread reduction in the PA, however it is largely habitual. Assessment of PA using the accelerometer is a good indicator and motivator, and it also serves as cognizance of the level and intensity of the PA carried out. The positive effect of PA on the body composition had often been confirmed. From the somatic viewpoint impact of PA is primarily perceived by the reduction of the fat component and increase in muscle mass (Sofková et al., 2014). Ross and Janiszewski (2008) and King, Hopkins, Caudwell, Stubbs, and Blundell (2009) have shown that the PA can provide health benefits and thus reduce the risk of obesity complications and improve mental well-being. Appropriate PA, which is available to everyone, regardless of age and gender, is walking.

Women with active PA level, owing to the daily number of steps and Tudor-Locke and Bassett (2004) classification, may be classified as active individuals and women with inactive PA level are considered as individuals with typical daily activities. Chan, Spangler, Valcour, and Tudor-Locke (2003) and Tudor-Locke and Myers (2001) pointed out that the smaller number of steps is related to the higher BMI. Řepka, Šebrle, Frömel, Chmelík, and Vašíčková (2011) and Whitt, Kumanyika, and Bellamy (2003) confirm that women with BMI < 25 carry out PA at higher level and walk greater number of steps per day than overweight and obese women. Wyatt, Peters, Reed, Barry, and Hill (2005) demonstrated that obese people (BMI > 30) walk 2,000 steps per day less than individuals with normal body weight. Tudor-Locke and Myers (2001) results indicate that more than, approximately, 9,000 steps/day is beneficial for the body composition and number of steps less 5,000 per day testifies to a sedentary way of life in the context of an unhealthy body composition.

The most variable component of body mass is fat, which is easily susceptible to developmental aspects and PA (Riegerová et al., 2006). On the basis of the fat fraction percentage average values, according to Heyward and Wagner (2004), groups of women that were classified as obese had more than 35% of the fat component. The fat component (BFP) exceeded in all sub-groups the 40% threshold, which is associated with significant negative health consequences. The increase of the fat component in relation to increasing age is confirmed, for example, by Kyle, Genton, Slosman, and Pichard (2001). Guo, Zeller, Chumlea, and Siervogel (1999) state that in adulthood the total amount of body fat increases approximately by 0.37 kg per year for men and 0.41 kg for women. Body fat distribution is determined genetically and partially regulated hormonally; consequently in postmenopausal women we

Table 3
Indices of selected body composition health indicators

	Maturus I (*n* = 118)		Maturus II (*n* = 103)	
	Adequate PA	Inadequate PA	Adequate PA	Inadequate PA
BMI (kg/m^2)	31.8 ± 4.5	34.6 ± 4.3	31.9 ± 3.7	33.2 ± 5.1
BFMI (kg/m^2)	13.2 ± 3.5	15.1 ± 5.1	13.7 ± 3.1	14.3 ± 4.1
FFMI (kg/m^2)	18.6 ± 1.6	18.9 ± 1.9	18.2 ± 1.2	18.8 ± 1.4*
BCMI (kg/m^2)	12.1 ± 1.1	12.3 ± 1.3	11.9 ± 0.8	12.2 ± 0.9*

Note. PA = physical activity, BMI = Body Mass Index, BFMI = Body Fat Mass Index, FFMI = Fat-free Mass Index, BCMI = Body Cell Mass Index. Values are given as *M* ± *SD*. *statistically significant difference between women with adequate and inadequate PA ($p < .05$).

may observe its redistribution from the peripheries to the abdomen (Toth, Tchernof, Sites, & Poehlman, 2000). Higher values of visceral fat determine abdominal obesity, one of the main assessment criteria of the metabolic syndrome, and they have almost comparable predictive value for major cardiovascular events as the increased levels of LDL cholesterol (Dukát et al., 2007). Average values of VFA reached in all sub-groups significant health risk threshold and ranged between 138.1 to 162.7 cm^2.

A change in approach to PA is demonstrated by greater decreases in fat fraction and maintaining fat-free mass (Sofková, Přidalová, Pelclová, & Dostálová, 2011). The greater the HPA level, the lower are the body composition health indicators, BMI and BFMI, which indicate the risk of obesity. In contrast, we find higher values of FFM, BCM and derived indices, FFMI and BCMI. Change in body fat precedes change in mass, particularly in people who sufficiently increased their PA (Sofková et al., 2014). Also studies of 69 African-American women aged 40 to 62 years (Hornbuckle, Basset, & Thompson, 2005) and 80 middle-aged women in the USA (Thompson, Rakow, & Perdue, 2004) showed a clear inverse relationship between the number of steps per day and the percentage of body fat. Engaging in everyday PA brings great benefits and is significantly reflected in body composition (Gába et al., 2009). Sofková, Přidalová, Mitáš, and Pelclová (2013) point to the fact that increase in walking is positively reflected into the healthier body composition.

There is a reciprocal relationship between the total body water and fat content. The water content is low in obese people, which makes up only 45% of body mass. Rokyta (2000) reported that the water content in the adipose tissue is only 10%. In younger women, we recorded 41.9% water in body weight (TBW: 38.4 l, weight: 91.6 kg) and 41.7% in older women (TBW: 36.5 l, weight: 87.4 kg). Gába and Přidalová (2014), Bedogni et al. (2002) and Ling et al. (2011) point to the decrease in TBW in relation to increasing age. Also Přidalová et al. (2008) and Přidalová, Sofková, Dostálová, and Gába (2011) demonstrated that in Czech women the TBW decreases with age and with the increase in BMI and proportion of the fat component (BFM).

In monitored sub-groups FFM decreases with age and the PA level. Representation of FFP in younger women was about 57.9% and 57.4% in older women. The older women with inadequate PA are the greater decrease in the amount of FFM. Gába and Přidalová (2014) point to the relationship of increasing age to slight decrease in FFM and at the same time increase in masse due the BFM increase.

Conclusions

Based on the PA monitoring and body composition health indicators associated with the obesity risk aspects we noted in obese and overweight women who had active level of PA lower levels of body fat (BFP, BFM) and less VFA in both age groups in comparison with women with inactive PA level. At the same time we recorded the increase in fat-free body mass (FFP, FFM).

Relative risk of damage to health as measured by the somatic indices (BMI, BFMI) is high in women irrespective of the PA level carried out.

Positive approach to PA focused on health promotion and healthy lifestyle may lead to smaller number of health problems associated with obesity. The relationship between health indicators of body composition and meeting recommended PA might be useful in strategies aimed at maintaining and developing a healthy lifestyle. Overweight and obesity do not constitute a significant barrier in undertaking an adequate level of PA.

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