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Original Article

Adiposity and physical activity in physically active and inactive elderly women at the university of third age in Palacký University Olomouc

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Abstract:
Background: Walking is a natural and effective form of physical activity and the core of all daily locomotion movements. The generally accepted value of 10,000 steps/day does not correspond with the elderly people; the recommendation for old person is above the limit of 7,100 steps/day. Purpose: The aim of this study was to characterize a group of elderly women attending the University of Third Age at the Faculty of Physical Culture, Palacký University Olomouc (U3A FPC UP Olomouc) regarding their body composition and physical activity and assess the differences between selected parameters of body composition in physically active and inactive women. Methods: The research group consisted of 106 women (aged 58–77 years) attending the U3A FPC UP Olomouc. The measurement of body composition was carried out using the bioelectric impedance method through the InBody 720 device. The number of steps was monitored using the Yamax DigiWalker SW-700 pedometer. To verify the strength of relation between variables Pearson correlation coefficient were calculated. Results: The participants are categorized as physically active women who meet the recommended limit of the number of steps/day with lowered physical activity at weekends, with the average value of the sample being above the limit of 7,100 steps/day. The research group was categorized as overweight according BMI (Body Mass Index; 26.4 ± 3.4 kg/m2) and BFMI (Body Fat Mass Index; 9.4 ± 2.7 kg/m2), with a risk of abdominal obesity (VFA: 118.0 ± 27.7 cm2, WHR: 94.2 ± 5.8%). The difference between physical active and inactive women and average values of the selected parameters of body composition was not statistically significant. Conclusion: The influence of physical activity, measured by the number of steps on the body composition, is thus very minimal and the intensity and spectrum of physical activity play a significant role.
Keywords: body composition, aging, walking, step count

Introduction

An active lifestyle, with a higher level of physical activity in elderly people, can slow down the upcoming involution changes. Physically active elderly people have almost two times lower risk of hospitalization, a shorter time spent in medical facilities, and almost two and half times lower costs of health care than physically inactive elderly people (Woolcott, Ashe, Miller, Shi, & Marra, 2010). The sedentary lifestyle is linked to higher health risks. The risk of mortality in physically inactive individuals can be up to 35% higher than in individuals with regular physical activity (Vuillemin, 2012). A longitudinal study by Gulsvik et al. (2012) demonstrated that the association between physical activity and mortality is consistent in all age categories and is independent from the initial age which is different than with the other risk factors (cholesterol, smoking).

For people above the age of 65y, the World Health Organization (World Health Organization, 2010) published general recommendations for physical activity. The compliance with this recommendation provides health benefits such as improvement in cardiorespiratory and muscle fitness, the state of bones and overall health, including the reduction of non-infectious diseases and depression. The walking is the core of almost all daily locomotion movements, and thus ranks among the natural, simple and effective forms of human movement and should be included in recommendation for physical activity (Pelclová, 2015; Schuna & Tudor-Locke, 2012). The generally used concept of 10,000 steps/day equals approximately the energy expenditure of 300–400 kcal/day (Tudor-Locke & Bassett, 2004). Tudor-Locke et al. (2011) have lowered the limit for elderly people from 10,000 steps/day to 7,100 steps/day. This value reflects 30-minute intensive walking over 5 days a week. The minimal values of steps in elderly people should range above the level of basal activity, i.e. in the range of 4,600–5,500 steps/day.

Regular physical activity prevents or reduces an increase in body weight and thus decreases the risk of obesity which is associated with higher risks of chronic diseases (Gulsvik et al., 2012; Vuillemin, 2012; World Health Organization, 2010). A study by Toth, Tchernof, Sites and Poehlman (2000) and also a study by Kuk, Saunders, Davidson and Ross (2009) confirmed that there is a significant increase in the absolute amount of

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subcutaneous and also splanchnic fat in postmenopausal women. According to Kuk et al. (2009), the excessive fat deposition in the visceral area, livers, heart, and muscles is associated with health risk, although it can have a different link to the metabolical and functional consequences in each area. Fat in the visceral area and in the liver is clearly linked, however, to metabolic disorders, although it does not have to be a predictor of functional limitations. Fat in other tissues such as the heart or skeletal muscle is linked to both functional limitations and metabolic disorders. A large cohort study by Pischon et al. (2008) has shown that high BMI and indicators of abdominal obesity (waist-hip ratio, WHR) are strong predictors of risk of death. High WHR also has a negative influence on people with low BMI. An increase of physical activity positively associates with the reduction of overall body fat, health benefits, but is dependent on the intensity and frequency of physical activity (Ross & Janssen, 2001). The amount of fat-free tissue and muscle tissue is decreasing with age (Schutz, Kyle, & Pichard, 2002), which leads to a gradual decrease in muscle strength (Porter, 2006). Amongst people over the age 80y can be identified a loss of muscle tissue by half, which also leads to a half size in muscle strength. In contrast, the percentage of adipose tissue and connective tissue in the skeletal muscle is increasing (Porter, 2006; Professional Associations for Physical Activity, 2010). Regular physical activity contributes to the maintenance of a functional independence of individuals, can prevent the occurrence of a number of diseases, a decline in functional capacity, and reduces the risks of falls and injuries (Ignasiak et al., 2011; Professional Associations for Physical Activity, 2010).

The aim of the study was to characterize a group of women U3A FPC UP Olomouc in relation to body composition and physical activity and assess the differences between selected parameters of body composition in physically active and inactive women.

Material and Methods

Participants

106 women aged 58–77 years, who were students of U3A FPC UP, participated in the measurement. The collection of data took place in 2014–2016. The women were tested in the anthropometric laboratory at FPC UP Olomouc and were informed about the aim of the study. They signed an informed consent with the study. The project was carried out in compliance with the approval of the Ethical Committee of FPC UP in Olomouc under the number 56/2012.

Body Composition Measurements

Body height was measured with an accuracy of 0.5 cm using the anthropometer A-226 (Trystom, Czech Republic). Body weight was measured with an accuracy of 0.5 kg and the analysis of body composition (BC) was carried out using the multi-frequency method of bioelectric impedance (DSM-BIA) through the InBody 720 device (Biospace Co., Seoul, Korea). The method is unified. The measurement took place under standard conditions. The InBody 720 device divides the body into five segments (left and right upper limb, torso, left and right lower limb) and uses an alternating electrical current with frequencies of 1–1000 kHz differentiating weight into total body water (intracellular and extracellular), proteins, minerals and body fat. In order to assess the risks of obesity, the health indicators of body composition were used: Body Fat Mass (BFM, kg, %), Body Mass Index (BMI, kg/m^2), waist–hip ratio (WHR, %) and the amount of visceral fat (VFA, cm^2). To complete information we added these parameters: Fat-free Mass (FFM, kg), Skeletal Muscle Mass (SMM, kg), Body Cell Mass (BCM, kg) and the size of basal metabolism (BMR, kcal). The World Health Organization (WHO) states the categories of overweight and obesity according to BMI (weight/height^2): overweight in the range of 25.0–29.9 kg/m^2, obesity above 30.0 kg/m^2 (World Health Organization, 2000). The categories according to BMI are not sufficient, however, as they do not provide information about the proportion of fat and fat-free tissue. In order to assess overweight and obesity, we also used Body Fat Mass Index (BFMI; amount of body fat/height^2) and Fat-free Mass Index (FFMI, the amount of fat-free tissue/height^2), which we have adopted from Kyle, Morabia, Schutz and Pichard (2004). Kyle et al. (2004) state the category of overweight according to BFMI in the range of 8.2–11.7 kg/m^2, according to FFMI in the range of 16.8–18.1 kg/m^2. The category of obesity includes, according to BFMI values ≥11.8 kg/m^2, according to FFMI values ≥18.2 kg/m^2.

Monitoring of Physical Activity

Physical activity was monitored using the Yamax DigiWalker SW-700 pedometer (Yamax Co., Tokyo, Japan), which is considered a valid device to measure the number of steps (Schneider, Crouter, Lukajic, & Bassett, 2003). The data of physical activity were recorded on a record sheet: Physical activity and healthy lifestyle – 12-week program using pedometers. The total number of steps is shown on the display of the device. The pedometer is attached to the right hip, and the participants were informed about wearing it throughout the day except for the time spent with water activities (bathing, showering, swimming, …). The participants attached the pedometer each morning after waking up, wore it the entire day, and before going to bed, recorded the number of steps and annulated the device. In order to assess the relationship between physical activity and body composition, we used the most active week, i.e. the second week of the measurement. The women were divided into two groups, group 1 which did not meet the recommendation for physical activity (≤ 7,100 steps/day), and group 2 which met the recommendation (> 7,100 steps/day).

Statistical analysis

After the measurement, the data taken by the InBody 720 were transferred into the MS Excel (Version 2013, Microsoft, Redmond, WA, USA) using the Lookin Body 3.0 program (Biospace Co., Seoul, Korea). The descriptive characteristics and data analysis were carried out using the Statistica statistical program (12.0., StatSoft, Tulsa, OK, USA). Normal data distribution was tested using the Kolmogorov-Smirnov test. The comparison of the selected parameters of body composition between physically active senior women and less physically active senior women was performed using the unpaired Student t-test. P-values below $\alpha = .05$ were considered statistical significance. The verification of the size of the associations between body composition and physical activity was calculated by the Pearson correlation coefficient.

Results

106 women participated in the study with an average age of 64.4 ± 3.7 years, height 162.6 ± 5.7 cm and weight 70.0 ± 10.4 kg. When assessing the risk of obesity on the basis of selected somatic indexes, the women were assessed in their average values regarding the risk of obesity, BMI (26.4 ± 3.4 kg/m2), BFMI (9.4 ± 2.7 kg/m2). The proportion of fat (BFM, %), with an average value of 35.1 ± 5.5% ranged the women just above the limit of the risk of obesity. The average amount of VFA (118.0 ± 27.7 cm^2) was above the limit denoting abdominal obesity. Abdominal obesity was also confirmed by the WHR, the value of which 94.2 ± 5.8% was above the recommended limit of 85% according to WHO (World Health Organization, 2011).

FFMI (kg/m^2) is related to the amount of fat-free tissue, with the average value of 17.0 ± 1.1 kg/m^2. The amount of SMM was represented with 24.5 ± 2.7 kg, the amount of BCM 29.1 ±3.0 kg, and the average values did not denote the reduction of muscle fraction.

The women walked on average 7,579 steps/day, during the working days 7,767 steps/day, and 7,111 steps/day at the weekend. The women were thus more physically active on working days than at the weekend, with a difference of 656 steps. The women were most active in the second week of the measurement, when they walked 7,731 steps/day. The lowest number of steps (7,393 steps/day) was identified in the fifth week of measurement (Table 1). The average value the women attained was above the recommended limit of 7,100 steps/day. They did not reach this limit on all weekends, but the physical activity reached the limit only on the first two weekends.

Table 1. Number of steps in individual weeks (W1–W6)

Weeks	Monday–Friday		Weekend		Monday–Sunday	
	M	SD	M	SD	M	SD
W1	7649	2915	7420	3622	7583	2816
W2	7910	2912	7283	3078	7731	2692
W3	7696	2952	7069	2831	7517	2673
W4	7870	2676	6951	2967	7607	2521
W5	7565	2881	6963	2787	7393	2628
W6	7909	2767	6977	3087	7643	2614
Total	7767		7111		7579	

Note: W1–W6 – week 1 to week 6

56.6% women met the recommended concept of 7,100 steps/day. These women walked on average 9,162 steps/day, while the remaining 43.4% women walked on average 5,433 steps/day (Table 2). The difference between the number of steps in group 1 and 2 was assessed as statistically significant.

We used the Pearson correlation coefficient to assess the association between body composition and the number of steps. The body composition was represented with selected parameters, and the number of steps was represented with the date from the second week of the measurement. The association between the number of steps and body composition was statistically significant mainly in the representation of adipose tissue, specifically in BFM (kg,%), VFA (cm^2), further it appeared in WHR and FS (Table 3).

We also assessed the differences in the observed parameters between groups 1 and 2 which were statistically significant in terms of the number of steps. The differences in the selected parameters of body composition were not statistically significant (Table 4).

Table 2. A comparison of the number of steps between groups 1 and 2 in relation to the recommendation of the number of steps/day

	Group 1 (n = 46)	Group 2 (n = 60)	p
Monday-Friday	5491.1	9424.4*	.0000
Saturday-Sunday	5289.0	8507.5*	.0000

*p < .05

Table 3. The association between the number of steps in the second week (W2) and selected parameters of body composition

Variable	W2 (n = 106)	
VFA (cm^2)	-.2156*	p = .026
WHR (%)	-.2332*	p = .016
BFM (kg)	-.1953*	p = .045
BFM (%)	-.2703*	p = .005
TBW (l)	.0326	p = .740
SMM (kg)	.0253	p = .797
FFM (kg)	.0318	p = .747
BMI (kg/m^2)	-.1658	p = .089

*p < .05

Note: VFA – Visceral Fat Area (cm^2), WHR – Waist-Hip ratio (%), BFM – Body Fat Mass (kg, %);, TBW – Total Body Water (l); SMM – Skeletal Muscle Mass (kg); FFM – Fat-free Mass (kg); BMI – Body Mass Index (kg/m^2)

Table 4. A comparison of selected parameters of body composition between groups 1 and 2 in relation to the recommended number of steps/day

Variable	Group 1 (n = 46)	Group 2 (n = 60)	p
BFM (%)	36.1	34.4	.112
VFA (cm^2)	121.0	115.7	.333
TBW (l)	32.7	33.3	.326
FFM (kg)	44.5	45.4	.325
SMM (kg)	24.2	24.7	.385
BCM (kg)	28.8	29.3	.385
BMC (kg)	2.6	2.7	.155
BMI (kg/m^2)	26.6	26.3	.706

Note: BFM – Body Fat Mass (kg, %); VFA – Visceral Fat Area (cm^2), TBW – Total Body Water (l), FFM – Fat-free Mass (kg); SMM – Skeletal Muscle Mass (kg); BCM – Body Cell Mass (kg); BMC – Bone Mineral Conten, (kg), BMR – Basal Metabolic Rate (kcal), BMI – Body Mass Index (kg/m^2)

Discussion

Aging is a process that has negative effects on almost all parameters of the human body (Kuk et al., 2009). The size of these changes is most likely influenced by gender, race or ethnicity, or possibly the amount of physical activity (Kuk et al., 2009; Kyle, Genton, Hans, Karsegard, Slosman, et al., 2001). Regular physical activity prevents or reduces an increase in weight, and thus reduces the risk of overweight and obesity, this being associated with increased mortality and chronic diseases (Gulsvik et al., 2012; Vuillemin, 2012; World Health Organization, 2010).

The research sample was according to BMI (26.4 ± 3.4 kg/m^2) and the WHO classification (World Health Organization, 2000) placed in the category of overweight. Research focused on assessing the relationships between BMI and the amount of body fat in women of European ethnicity (De Lorenzo et al., 2003; Gómez-Ambrosi et al., 2012) states a high specificity but a lower sensitivity. A study by Gómez-Ambrosi et al. (2012) states that the risk limit for obesity according to BMI in women has a 98% specificity but only a 65% sensitivity. They therefore adjusted the risk value for obesity according to BMI in the research to 26.8 kg/m^2, which has 85% sensitivity and 88% specificity. In the Czech environment, Gába and Přidalová (2016) were interested in this problem in their research, which introduced the limit value for obesity to be 26.7 kg/m^2 for women aged 40–64y and the limit value of 26.3 kg/m^2 for women above the age of 65y, with the specificity in both cases above 83% and with the sensitivity above 84%. Based on these categories, the sample was close to risk of obesity. The value of BFMI ranks the sample into the category of overweight (Kyle, Morabia, et al., 2004). Body fat grows in adulthood (Kyle, Genton, Hans, Karsegard, Michel, et al., 2001) with its peak appearing between the fifth and seventh decade of life, while afterwards it is either maintained or decreased (Kuk et al., 2009). The increase in fat has also been confirmed by a study by Guo, Zeller, Chumlea and Siervogel (1999), which states an increase by 0.41 kg per year in women. Women aged 64y in their sample demonstrated a value of fat 22.6 ± 8.0 kg. In Czech women, Gába and Přidalová (2014) state the average values of BFM 25.9 ± 7.9 kg in women aged 60–69y. The values in our study range in similar values. The percentage values of BFM 28–35% are assessed as a risk of overweight, with values above 35% being a risk of obesity (Heyward & Wagner, 2004). Concerning the average value, the sample is almost at the level of risk of obesity. Only 11.3% women were in the norm regarding the BFM (%), 39.6% of women were in the category of risk of overweight and 49.1% in the risk of obesity. In postmenopausal women, a redistribution of fat tissue occurs, from the peripheries to the abdominal area (Kuk et al., 2009; Toth et al., 2000). 24.5% of participants were without the risk of obesity, 66.0% of participants were in the medium risk of abdominal obesity (100–150 cm^2) and 9.5% of participants were in the category of high risk (> 150 cm^2). The risk of storing fat in the central area is also confirmed by the value of WHR, which denotes a high risk of abdominal obesity. The redistribution of fat tissue into the abdominal area is also confirmed in Czech women by research carried out by Gába and Přidalová (2014), which verified the increase of VFA depending on age on average by 2.28 cm^2/year.

The amount of fat-free tissue decreases depending on age, which is confirmed by a study by Schutz et al. (2002) and a study by Forbes (1999). In the Czech Republic, Gába and Přidalová (2014) confirmed this. The amount of FFM was significantly lower in international studies focused on the research of elderly women (Hughes, Frontera, Roubenoff, Evans, & Fiatarone Singh, 2002; Kyle, Genton, Hans, Karsegard, Michel, et al., 2001; Schutz et al., 2002) than the results of our study. Research amongst women in the Czech Republic (Gába & Přidalová, 2014; Gába, Riegerová, & Přidalová, 2009) is coincident, however, in an average amount of FFM. The same also demonstrated higher values of BCM and SMM than the results in the study by Kyle et al. (2001). BCM, which is a metabolically active component of FFM, is ideally represented by 40% of weight (Talluri et al., 2003). The value of BCM related to $height^2$ (BCMI – Body cell mass Index, kg/m^2) is sensitive to changes in the state of proteins and FFM, and thus can point at the loss of muscle mass and the risk of sarcopenia (Kyle, Genton, Hans, Karsegard, Slosman, et al., 2001; Talluri et al., 2003). The limit value according to research by Kyle, Genton, Hans, Karsegard, Slosman et al. (2001) is < 6.96 kg/m^2 for women. The average value of the sample which is 10.1 ± 0.8 kg/m^2 is thus without the risk of sarcopenia.

In the total average of number of steps/day, 15.1% of women were found in the category of "sedentary behavior" according to Tudor-Locke and Bassett (2004) and Tudor-Locke et al. (2011) in the sample with 28.3% of women being insufficiently active, 44.3% being sufficiently active, and 12.3% being highly active. The high activity is influenced by the selection of the sample that comprises women more active in walking (Pelclová, 2015; Zając-Gawlak et al., 2016). In comparison with international research, inhabitants in the Czech Republic walk more than inhabitants in the USA (Newton, et al., 2013; Payn et al., 2008; Tudor-Locke, Johnson, & Katzmarzyk, 2009). A similar number of steps was found with Belgians (De Cocker, Cardon, & De Bourdeaudhuij, 2007), a higher number of steps was found in a study of Polish women (Zając-Gawlak et al., 2016), which focused on the same group of women – students of U3A who tend to be more physically active in comparison with their peers. Women demonstrated higher physical activity during the working week than at the weekend, with this trend also being apparent in adulthood (Tudor-Locke et al., 2004) and in older women (Stycker, Duncan, Chaumenton, Duncan, & Toobert, 2007), which has been confirmed by research in older women in the Czech Republic (Cuberek et al., 2014; Pelclová, 2015).

A number of studies deal with the relationships between physical activity and its influence on the health of elderly people. Schmidt, Cleland, Shaw, Dwyer and Venn (2009) studied the relationships between the number of steps and the risk of cardio-metabolic diseases, including measuring waist circumference, systolic pressure, glucoses, triglycerides and HDL cholesterol. Individuals who reached 5,000 steps/day demonstrated a significantly lower occurrence of undesirable indicators of cardio-metabolic risks. In the research by Zając-Gawlak et al. (2016), they found more favorable lipid profiles in the more active population represented by students of U3A along with lower insulin resistance than in persons of the same age, but with lower physical activity. According to studies by Garber et al. (2011) and Newton et al. (2013), meeting the recommendations for physical activity can be associated with positive changes in the risk factors linked to cardiovascular diseases.

We found a significant relationship between the number of steps and the representation of adiposity tissue (BFM, VFA) in the sample and that also on the WHR index. The relationship between these parameters was also found in other studies focused on students of U3A (Pelclová, Gába, Tlučáková, & Pośpiech, 2012; Zając-Gawlak et al., 2016). A number of authors also found a significant relationship between BMI and the number of steps (Payn et al., 2008; Tudor-Locke et al., 2009), although such a significance has not been confirmed in our sample. Certain authors do not recommend the assessment of the basis of BMI (Gába & Přidalová, 2016; Kyle, Genton, Gremion, Slosman, & Pichard, 2004; Schutz et al., 2002), but instead prefer the use of BFMI and FFMI, with significant relationships between them and physical activity, this being confirmed in the study by Kyle, Genton, et al. (2004).

Similar differences in the parameters of body composition, between more and less physically active women, were found in research on Polish students of U3A (Ignasiak, Skrzek, & Dąbrowska, 2009) in BFM and TBW, in the research by Kyle, Genton, et al. (2004), the difference between physically active women and sedentary women, in terms of the amount of BFM and FFM. In the research by Pelclová et al. (2012), there was a statistically significant difference between women who met the recommended number of steps and who did not in the somatic indicators of health (BMI, BFMI, WHR, VFA). This research uses, however, the limit of 10,000 steps/day.

Conclusions

Senior women studying at the U3A at FPC UP were assessed as more physically active women, who meet the recommended limit of the number of steps/day and with lower physical activity at the weekend. Despite this fact, it is a group of women who are found in the category of overweight with the risk of abdominal obesity (VFA, WHR) in terms of the somatic indexes (BMI, BFMI). Physically active and inactive women did not significantly differ in the average values of selected parameters of body composition. The influence of physical activity measured by the number of steps on the body composition, is thus minimal, with a significant role taken by the intensity and the spectrum of physical activity.

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