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PHYSICAL ACTIVITY AND OBESITY: COMPARISON BETWEEN DIFFERENT APPROACHES

ABSTRACT: The present study aims to investigate the level of physical activity in people living in Brno and the surrounding areas, particularly those who are obese. The purpose of this study is to find out whether questionnaires or objective pedometer data are reliable for monitoring activity levels. A total of 508 individuals (380 females and 128 males) were enrolled in the study. The study volunteers ranged in age from 16 to 73 years (45±12 years) and had a mean body mass index (BMI) 33±8 kg/m^2. We found a significant negative relationship between the number of steps per day and the percentage of body fat, waist circumference, hip circumference, waist to hip ratio, body mass index and waist to height ratio. Individuals classified as having normal body weight performed significantly more steps per day than those classified as obese. Only a little data obtained from the questionnaire correlated significantly with anthropometric measures and when applied to the analysis based on BMI categories, the differences between categories were not significant. Results suggest that a pedometer-determined walking activity is the proper method for the evaluation of physical activity levels. This data can lead to recommendations for a minimum amount of steps per day associated with optimal body composition. Data obtained from the questionnaire was not found to be relevant for activity level evaluation and recommendations.

KEY WORDS: Anthropometry – Obesity – Pedometer – Physical activity

INTRODUCTION

The lifestyle in the human society of the 21st century is very different from the past. For centuries, there was a close association between caloric intake, as food energy, and caloric expenditure, as physical activity. In a modern Westernized society, the requirement of physical activity for daily life is much lower. In addition, changes in the food industry, such as an increased supply of lower cost, high-energy ingredients, and effective marketing strategies targeted at children and adolescents, are important factors contributing to an accelerating increase in BMI (Eaton, Eaton 2003, Hardus *et al*. 2003). The discordance between our contemporary lives and our genetic makeup has important pathophysiological implications for our health (Eaton, Eaton 2003). In recent years, overweight individuals and obesity have become mass phenomena the prevalence of which has dramatically increased in both developed and developing countries (Agyemang *et al.* 2009, Lev-Ran 2001). Obesity has been shown to have strong associations with a range of health problems, including cardiovascular diseases, atherosclerosis, type-2 diabetes, insulin-resistance syndrome, systemic pro-inflammatory state, hypertension, some types of cancer (e.g. colorectal carcinoma), gall bladder diseases, disturbances in plasma glucose, insulin and lipid levels, gynecological problems, psychosocial problems and is considered an important component of metabolic syndrome (Després, Lamarche 1993, Jasieńska *et al.* 2004, Morán *et al*. 1999, Reilly, Rader 2003, Vague 1956, Welborn *et al*. 2003, You, Nicklas 2008). All these diseases can cause premature death and represent a severe psychosocial burden to society.

Generally, the development of fat deposits depends on the balance between energy intake and energy expenditure.

Total energy expenditure (TEE) consists of resting metabolic rate (RMR), energy cost of arousal, diet-induced thermogenesis and activity-induced energy expenditure (AEE). Of these components, AEE is the most variable one between individuals. AEE is measured by the amount of physical activity, the intensity of this activity and body characteristics. In daily life, the contribution of AEE to TEE can range from 25% in sedentary persons to 75% in extreme situations (Horton, Hill 1998, Joosen *et al*. 2005). Theoretically, in case it is not entirely compensated for by increased energy intake or reduction of physical activity between exercise sessions, the increased daily energy expenditure (mainly during routine and regular exercise sessions) should result in negative energy balance and eventual weight loss. There are several mechanisms by which physical activity could accelerate fat oxidation. It is known that exercise increases metabolic mechanisms, which are necessary to oxidize fat, such as lipoprotein lipase, CPT-I and the number of mitochondria (Holloszy, Coyle 1984, Smith *et al.* 2000). Aerobic exercise stimulates sympathetic nervous system activity, which can result in enhanced fat oxidation. In addition, exercise supports the growth of muscles. Adipose tissue and skeletal muscle differ strikingly with regard to their participation in carbohydrate metabolism. One gram of muscle can remove from the blood far more glucose than a gram of fat, fit muscle has more capacity for blood glucose extraction than unconditioned muscle (Hayashi *et al*. 1997). This is analogous with the metabolism of free fatty acids. Skeletal muscle can oxidize more ingested fatty acid than an equal mass of adipose tissue and the discrepancy is increased by exercise (Smith *et al.* 2000). However a systematic review of research reports published between 1980 and early 2000, restricted to Caucasian adults, revealed inconsistent results in the effect of physical activity on weight changes (Fogelholm, Kukkonen-Harjula 2000). Most studies with follow-up data on physical activity found an inverse association between physical activity and long-term weight gain. On the other hand, the prospective studies with physical activity measured at baseline, and randomized weight reduction interventions, gave inconsistent results regarding the effect of increased physical activity on weight change (Fogelholm, Kukkonen-Harjula 2000).

In 1997 the American College of Sports Medicine and the American Heart Association updated the recommendation for adults on physical activity and public health. According to this recommendation healthy adults (18–65 years old) need moderate-intensity aerobic physical activity for a minimum of 30 minutes 5 days per week or vigorous-intensity aerobic activity for a minimum of 20 minutes 3 days per week to promote and maintain their health (both accumulated in bouts of at least 10 minutes). A combination of both intensities of aerobic physical activity can be performed to meet this recommendation as well (Haskell *et al.* 2007). Moderate-intensity aerobic activity is generally represented by a brisk walk which accelerates the heart rate. Vigorous-intensity activity is generally exemplified by jogging, and causes rapid breathing and a high heart rate. Adults should also perform activities that maintain or increase muscular strength and endurance on a minimum of 2 days each week. Muscle-strengthening activities include, for example, a progressive weight-training program which uses the major muscle groups (Haskell *et al.* 2007).

Although self-report approaches to measuring physical activity are considered important to research, there is an increasing interest in objective monitoring of daily physical activity using accelerometers and pedometers. Both motion sensors are small, light-weight and are worn comfortably at the waist, though the pedometer is much simpler in design, requires no additional software and offers a better solution for a low cost (Tudor-Locke 2002). The popular health message of "10,000 steps a day" (Hatano 1993), recommends taking 10,000 steps each day (Chastin *et al.* 2009). Tudor-Locke and Bassett 2004 proposed the following preliminary indices be used to classify pedometer-determined physical activity in healthy adults: <5,000 steps/day for "sedentary life-style"; 5,000–7,499 steps/day for "low active"; 7,500–9,999 steps/day "somewhat active"; ≥10,000 steps/day for "active" and individuals who take >12,500 steps/day are likely to be classified as "highly active" (Tudor-Locke, Bassett 2004). In general, a negative correlation is observed between the level of physical activity measured by pedometers and the level of body fat (Clemes *et al*. 2008, Després, Lamarche 1993, Smith *et al*. 2008, Tudor-Locke *et al.* 2001).

The present study aims to investigate the level of physical activity in people living in Brno and the surrounding areas by using questionnaires and pedometer data and to find out which of these methods of data recording is most suitable for scientific purposes.

MATERIAL AND METHODS

Subjects

A total of 508 subjects (380 females and 128 males) were enrolled in the study. Subjects were recruited through an announcement in the mass media (radio, television, web pages) in Brno (Czech Republic) and neighbouring regions. Volunteers ranged in age from 16 to 73 years with median 46.8 years (47.4 y in females, 43.6 y in males). All subjects read and signed a written consent form, which has been archived. The whole study was approved by the Ethical Committee of the Faculty of Medicine of Masaryk University, Brno. Descriptive data for age, BMI, WHR, WHtR, percentages of body fat and water, waist and hip circumference, steps per day and time devoted to physical work, walking, sport, and other physical activity (in hours at 7 days) for each gender group are presented in *Table 1.*

Methods

Height and weight were measured without shoes and in underwear using a digital scale (SECA 764). The waist and hip circumferences (cW, cH) were measured with the

TABLE 1. Descriptive statistics of data obtained.

	Females			Males			Total sample		
	Valid N	**Mean**	**Std. Dev.**	**Valid N**	**Mean**	**Std. Dev.**	**Valid N**	**Mean**	**Std. Dev.**
age	380	45.8	13.1	128	44.2	13.5	508	45.4	13.2
%BF	380	40.4	9.7	128	28.2	8.7	508	37.3	10.8
%BW	380	44.7	6.2	128	51.9	6.3	508	46.5	6.9
cW (cm)	380	98.6	18.0	128	110.9	18.7	508	101.7	18.9
cH (cm)	380	115.4	15.2	128	112.3	12.4	508	114.6	14.6
WHR	380	0.85	0.08	128	0.98	0.09	508	0.88	0.1
BMI	380	32.6	8.0	128	33.1	7.3	508	32.7	7.8
WHtR	380	0.6	0.12	128	0.63	0.11	508	0.61	0.11
SW	380	7,541.1	3,028.4	128	7,454.0	3,339.0	508	7,519.1	3,106.4
SWD	380	6,410.3	3,657.9	128	6,734.5	3,700.8	508	6,492.0	3,667.8
ST	380	7,218.9	2,874.9	128	7,248.4	3,164.1	508	7,226.4	2,947.2
QT_work	380	25.2	16.1	128	21.7	16.9	508	24.3	16.4
QT_walk	380	9.2	5.6	128	9.3	5.6	508	9.2	5.6
QT_sport	380	2.0	3.4	128	2.6	3.5	508	2.2	3.4
QT_other	380	2.2	3.9	128	1.5	2.7	508	2.0	3.6
QT_total	380	38.6	17.5	128	35.0	17.4	508	37.7	17.5

%BF – percent of body fat; %BW – percent of body water; cW – waist circumference; cH – hip circumference; WHR – waist to hip ratio; BMI – body mass index; WHtR – waist to height ratio; SW – steps per day taken during the week; SWD – steps per day taken during the weekend; ST – steps/day taken in total; 7 days physical activity (in hours) presented by physical work – QT_work, walking – QT_walk, sport – QT_sport, other physical activity – QT_other, QT_total – sum of QTs.

accuracy to the nearest 0.5 cm. The waist circumference was measured at the umbilicus level. Body mass index (BMI) was computed as weight in kilograms divided by height in meters squared, waist to hip ratio (WHR) was computed as the circumference of the waist divided by the circumference of the hips, waist to height ratio (WHtR) was computed as the circumference of the waist divided by the body height. Percentage of body fat (%BF) and percentage of body water (%BW) were determined using a Bodystat 1,500 MDD body composition analyzer. Bodystat works by passing a safe battery-generated signal through the surface electrodes placed on the hand and foot. Bioelectrical impedance analysis (BIA) is a commonly-used method for estimating body composition in subjects without significant fluid and electrolyte abnormalities (Kyle *et al.* 2004).

Subjects were instructed to wear the pedometer (Omron HJ-113W-E) and to record the total number of steps taken each day. The pedometer was worn in the trouser pocket or attached to the waistband of the clothing. Subjects wore the pedometer for one week (seven days) and were encouraged not to alter their usual physical activity.

During the same seven-day time period participants recorded their physical activity on the questionnaire. The questionnaire was focused on the time (in hours per day) devoted to physical work, walking, sport and other physical activity. In addition, the self-evaluated intensities of these activities were recorded (10-point score). Data obtained from the questionnaire was evaluated in two ways: as rough values of time spent by activity and as a time multiplied by the corresponding intensity score.

Data treatment

Walking activity (steps per day), questionnaire and anthropometrical data were evaluated as continuous variables using Statistica software (version 9.0). Normality was assessed by using Shapiro-Wilk's test of normality with significance set at an alpha level of $p<0.05$. Relations were described using non-parametric (Spearman) correlations at a 5% level of significance. Walking activity (steps per day) was also examined as a categorical variable defined as a low, moderate and high activity level using the 25th and 75th percentiles for distribution. In the low activity level category individuals took less than 5,102 steps per day, in the moderate activity level category 5,102–8,982 steps per day and in the high activity level more than 8,982 steps per day. BMI was examined as a continuous variable, as well as a categorical variable defined as underweight (U; BMI<18.50), normal weight (N; BMI=18.5–24.9), overweight (OW; BMI=25.0–29.9), and obese (OBI; BMI=30.0–34.9, OBII; BMI=35.0–39.9, OBIII; BMI=40.0–44.9, MO; BMI>45.0) categories. A Mann-Whitney U test was used for the comparison of differences between males and females. The relationship between physical activity and estimates of body composition was further examined using Kruskal-Wallis ANOVA and by multiple comparison of z' values.

RESULTS

The distribution of individuals across BMI categories by sex is presented in *Figure 1.* Individuals were most often classified as obese (62.2% in categories OBI-MO), specifically in the OBI category (27.2%). This category was followed by overweight (OW; 22.4%) and OBII (19.3%). 14.6% of those surveyed were classified as being of a normal weight, according to BMI categories.

The differences between the sexes were examined using the Mann-Whitney U test. The sexes differ significantly

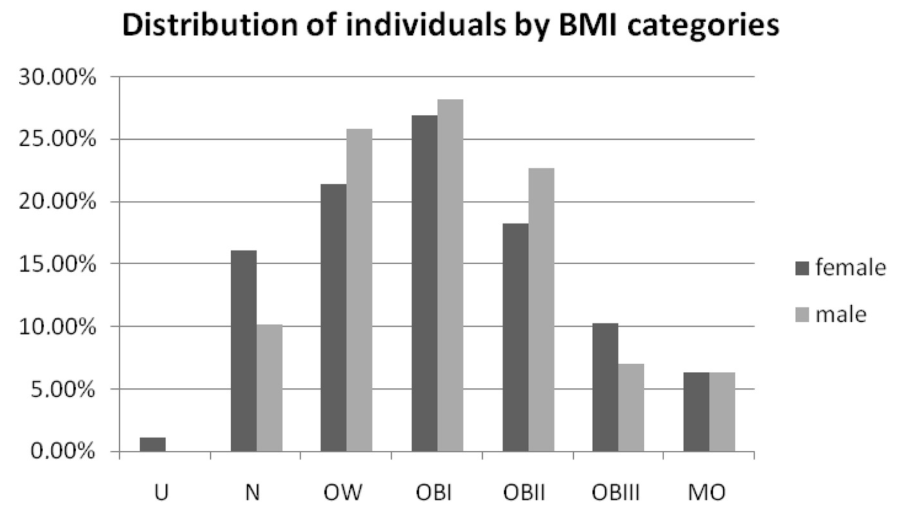

FIGURE 1. Distribution of individuals by BMI categories: U – underweight, N – normal weight, OW – overweight, OBI-MO – obese.

in all anthropometrics measurements except the BMI and WHtR. Females had a significantly higher percentage of body fat (40.4% to 28.2% in males, p=0.00) and hip circumference (115.4 cm to 112.3 cm in males, p=0.02) as opposed to males who, in turn had a higher percentage of body water (51.9% to 44.7% in females, p=0.00), waist circumference (110.9 cm to 98.6 cm in females, p=0.00) and WHR (0.98 to 0.85 in females, p=0.00). In physical activity level estimated as steps per day the differences between both sexes were not significant. In time devoted to physical activity the sexes differ significantly in the amount of physical work (25.2 hours per week in females and 21.7 hours per week in males, p=0.01) and in the total amount of physical activity (38.6 hours per week in females and 35 hours per week in males, p=0.04).

From correlation analysis we found out that the number of steps per day correlate significantly negatively (p<0.05) with age, percentage of body fat, waist circuference, hip circumference, WHR, BMI, WHtR and significantly positively (p<0.05) with percentage of body water (*Table 2*). Time spent doing physical work correlates significantly positively (p<0.05) with the percentage of body fat and WHtR, although when intensity was accounted for, the waist and hip circumferences and BMI also showed significant positive correlation and percentage of body water significant negative correlation (p<0.05) (*Table 2*). Time spent walking has no significant relationship to anthropometric measures, even when intensity is considered (*Table 2*). Both the amount of sport and sport with intensity, correlate significantly negatively with the percentage of body fat, waist circumference, hip circumference, BMI, WHtR and significantly positively with percentage of body water (p<0.05) (*Table 2*). The amounts of other physical activity and of other physical activity with intensity correlate significantly negatively with age, waist circumference WHR and WHtR (p<0.05) (*Table 2*).

According to the frequency tables, in the lowest activity tertile 18.5% of individuals were classified as obese, compared with 11.4% of those in the highest

TABLE 2. Spearman correlation coefficients between anthropometrical data and physical activity.

	Age	%BF	%BW	cW	cH	WHR	BMI	WHtR
Steps/day	–0.20*	–0.27*	0.24*	–0.32*	–0.29*	–0.20*	–0.33*	–0.33
QT_work	0.08	0.11*	–0.08	0.05	0.07	–0.01	0.07	0.09*
QT_walk	–0.04	–0.08	0.07	–0.07	–0.06	–0.03	–0.07	–0.07
QT_sport	–0.06	–0.14*	0.13*	–0.11*	–0.13*	–0.03	–0.13*	–0.13*
QT_other	–0.17*	–0.06	0.05	–0.11*	–0.07	–0.10*	–0.08	–0.11*
QT_total	0.02	0.03	–0.02	–0.01	0.00	–0.03	0.00	0.02
QT&I_work	0.06	0.12*	–0.11*	0.10*	0.10*	0.03	0.11*	0.13*
QT&I_walk	–0.05	–0.08	0.07	–0.05	–0.05	–0.01	–0.07	–0.06
QT&I_sport	–0.07	–0.14*	0.13*	–0.11*	–0.13*	–0.04	–0.13*	–0.14*
QT&I_other	–0.17*	–0.07	0.05	–0.10*	–0.07	–0.09*	–0.08	–0.11*
QT&I_total	–0.02	0.04	–0.04	0.03	0.02	0.01	0.03	0.04

%BF – percent of body fat; %BW – percent of body water; cW – waist circumference; cH – hip circumference; WHR – waist to hip ratio; BMI – body mass index; WHtR- waist to height ratio; 7 days physical activity (in hours) presented by physical work – QT_work; walking – QT_walk; sport – QT_sport; other physical activity – QT_other; QT_total – sum of QTs; 7 days physical activity (in hours) multiplied by the corresponding intensity score – abb. QT&I; * p<0.05.

activity tertile. Similarly 1.6% of individuals in the lowest activity tertile were classified as having normal weight compared with 6.3% of those in the highest activity tertile (Chi-square=22.26, p=0.00).

Table 3 presents Kruskal-Wallis ANOVA and a comparison of variables between pedometer-determined activity categories. Multiple comparison of z' values revealed that with regard to the age of participants, there are significant differences between low activity versus high activity categories ($p<0.05$). Individuals in the high activity category are on average 43 years old compared to the individuals in the low activity category, who are on average 49 years old. Individuals in the high activity category have on average 34% body fat, a mean BMI of 30 kg/m^2 and a mean WHtR of 0.57, which are significantly lower values in comparison with the 37% body fat average, mean BMI of 33 kg/m^2 and a mean WHtR of 0.60 in the moderate activity level, and with the average 40% body fat, mean BMI of 36 kg/m^2 and a mean WHtR of 0.66 in the low activity level ($p<0.05$). There were no differences in %BF between the moderate and low activity categories. % BW is significantly higher in the high activity level (48%) versus the moderate (46%) and low (45%) activity levels ($p<0.05$). There were no differences in %BW between the moderate and low activity categories. Significant differences between all activity categories were recorded for waist and hip circumferences ($p<0.05$). In the low activity level both have higher values (110 and 120cm respectively) in comparison with values in the moderate (101 and 114cm respectively) and in the high activity levels (95 and 109 cm respectively). For WHR the value of 0.92 in the low activity category is significantly higher than 0.88 in the moderate and 0.86 in high activity categories ($p<0.05$). The difference is not significant between the moderate and high activity categories.

Table 4 presents a Kruskal-Wallis ANOVA and a comparison of variables between BMI categories. As expected, the multiple comparisons of z' values revealed that anthropometric data (percentages of body fat and water, waist and hip circumferences, WHR and WHtR) was significantly different between individuals in the normal weight category and overweight and obese BMI categories ($p<0.05$). The individuals in the normal weight category are also significantly younger (being on average

TABLE 3. Kruskal-Wallis ANOVA and description of anthropometric variables across activity level categories.

	Kruskal-Wallis test	Low N=127		Moderate N=254		High N=127	
	H	Mean	SD	Mean	SD	Mean	SD
Age	13.13*	49	13	45	13	43	13
%BF	22.15*	40	11	37	10	34	11
%BW	16.62*	45	7	46	7	48	8
cW	38.79*	110	19	101	18	95	18
cH	31.51*	120	16	114	14	109	13
WHR	18.87*	0.92	0.10	0.88	0.10	0.86	0.10
BMI	39.76*	36	9	33	7	30	7
WHtR	40.60*	0.66	0.12	0.60	0.11	0.57	0.11

%BF – percent of body fat; %BW – percent of body water; cW – waist circumference; cH – hip circumference; WHR – waist to hip ratio; BMI – body mass index; WHtR- waist to height ratio; * p<0.05.

TABLE 4. Kruskal-Wallis ANOVA and description of variables across BMI categories.

	Kruskal-Wallis test	U N=4		N N=74		OW N=114		OBI N=138		OBII N=98		OBIII N=48		MO N=32	
	H	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	103.63*	27	6	33	11	43	13	48	12	50	11	52	11	51	11
%BF	295.38*	22	1	24	7	32	8	38	7	43	7	49	5	53	6
%BW	268.66*	58	1	55	4	49	5	46	5	43	5	39	4	38	4
cW	407.39*	64	4	75	7	91	8	102	8	114	9	122	9	136	12
cH	408.26*	85	4	97	5	105	5	114	6	122	7	131	6	147	11
WHR	167.40*	0.75	0.02	0.77	0.06	0.86	0.08	0.90	0.08	0.94	0.09	0.94	0.09	0.93	0.09
WHtR	428.82*	0.39	0.02	0.45	0.04	0.54	0.05	0.61	0.04	0.69	0.04	0.74	0.05	0.82	0.07
ST	57.43*	7,374	1,854	8,845	3,340	7,790	2,808	7,166	2,677	6,665	2,871	6,463	2,266	4,580	2,213
QT&I_work	7.62	117	108	107	84	117	93	121	102	130	105	156	119	140	97
QT_sport	8.19	0.9	0.9	2.9	3.8	2.5	4.2	2.3	3.4	1.7	2.6	1.5	2.5	1.5	2.4

%BF – percent of body fat; %BW – percent of body water; cW – waist circumference; cH – hip circumference; WHR – waist to hip ratio; WHtR – waist to height ratio; ST – steps/day taken in total; QT&I_work – 7 days physical work (in hours) multiplied by the corresponding intensity score; QT_sport – 7 days physical activity (in hours) represented by sport; * p<0.05.

33 years old) than individuals in the overweight (43 years old) and obese (OBI-MO together on average 50 years old) categories ($p<0.05$). There is a significant difference across BMI categories for steps per day, with subjects classified as normal weight taking significantly more steps per day than those classified as obese ($p<0.05$). There is no significant difference in steps per day between normal weight subjects and those classified as overweight. Normal weight individuals take on average 8,845 steps/day in contrast to on average 7,790 steps/day in overweight and 6,219 steps/day in all obese individuals (OBI-MO). There is not a significant difference between subjects classified as normal weight and those classified as underweight in any of variables. Across BMI categories individuals do not differ in the time devoted to sport activity and time and intensity devoted to physical work.

DISCUSSION

The aim of the current study was to investigate the level of physical activity, particularly in obese people and to establish an appropriate method for the evaluation of physical activity. We decided to use pedometers because, as Tudor-Locke states, "they are practical, accurate and suitable tools for measurement and motivation in common physical activity" (Tudor-Locke 2002). Pedometers can be used equally well by both researchers and patients and therefore offer a simple opportunity to bridge the gap between research and practice. For collecting, reporting and interpreting pedometer data, it has been recommended to universally adopt steps taken, or "steps per day" as a standard unit of measurement (Bassett *et al.* 1996, Hendelman *et al.* 2000). However pedometers show error during slow walking, studies have shown that pedometers are most accurate at measuring steps taken, less accurate at estimating distance travelled and even less at estimating energy expenditure (Bassett *et al.* 1996, Hendelman *et al*. 2000). Participants of our study wore pedometers for one week (seven days). A full week of continuous monitoring is most effective if the purpose of the study is to examine cyclical patterns of daily physical activity, or to promote individual awareness of personal patterns of daily physical activity as a part of a behavioural modification program (Tudor-Locke 2002).

The mean pedometer values recorded for the present sample (7,226±2,947 steps/day) are similar to those reported by Tudor-Locke *et al.* (7,370±3,080 steps/day), which represent data from the American population, but lower than those reported by Clemes *et al.* (9,192±3,127 steps/day) (Clemes *et al*. 2008, Tudor-Locke *et al*. 2001). Although the study of Clemes *et al.* represents the European population, we have to consider the fact that individuals in our sample have a higher mean age (45.4±13.2 years) as well as higher a mean BMI (32.7±7.8 kg/m^2) than those in Clemes *et al.* study with participant's mean age of 38.5±13.1 years and BMI of 27.7±5.3 kg/m^2 (Clemes *et al*. 2008, Tudor-Locke *et al.* 2001). Based on a systematic review of 32 studies we could suggest lowering the number of steps per day with increasing age (Tudor-Locke 2002). In our study we found significant differences between the low activity (less than 5,102 steps per day) and the high activity (more than 8,982 steps per day) categories with individuals being on average six years younger in the high activity than in the low activity category. The mean pedometer values recorded for the present sample (7,226±2,947 steps/day) were also lower than the recommended 10,000 steps a day, with only 15% of the participants meeting the 10,000 step guidelines. Such a low compliance with the guidelines could be explained by the relatively high BMI and age of the participants. Preliminary evidence suggests that a goal of 10,000 steps/day may not be sustainable for some groups, including older adults and those living with chronic diseases (Tudor-Locke, Bassett 2004).

Differences between the sexes in physical activity level measured as steps per day were negligible. Clemes *et al.* and Tudor-Locke *et al*. did not find significant differences in pedometer-determined activity level between males and females either (Clemes *et al.* 2008, Tudor-Locke *et al.* 2001).

Data from the questionnaire was recorded as time devoted to activities in hours and self–reported intensity. We supposed that this would provide a better insight into the participant's daily habits. The individuals spent 24.3±16.4 hours weekly doing physical work, 9.2±5.6 hours walking, 2.2±3.4 hours participating in sport and 2.0±3.6 doing other physical activities. The correlation analysis revealed significant relationships between some of these activities and anthropometric measures, however when applied to the analysis based on BMI categories, the differences were not significant. We also discovered some unexpected results. Time spent walking (QT_walk) does not correlate significantly with any of anthropometric measures, nor with steps taken ($\rho=0.08$, $p>0.05$). In addition, the amount of physical work (QT_work) had a significant positive relationship with BMI, percentage of body fat and waist and hip circumferences ($p<0.05$). This result could be explained by the fact that the more time is spent doing physical work, the more time is devoted to relaxation and the less time is devoted to intensive leisure-time activities, for example sport. We investigated this relationship and it was found to be significant ($\rho=-0.11$, $p<0.05$). It seems that these categories (QT_work, QT_walk) are unsuitable for evaluation of physical activity and we cannot recommend their use. Although not significant across BMI categories, sport activity seems to be a good indicator of physical activity level.

The best results were obtained from pedometer-determined walking activity. We found a significant negative relationship between the number of steps per day and the percentage of body fat, waist circumference, hip circumference, WHR, BMI and WHtR ($p<0.05$). The same trend, valid for BMI and the percentage of body fat was previously described by other authors (Tudor-Locke *et al.* 2001). This is consistent with results obtained from the analysis of variables by activity level and BMI categories. For the activity level categories we have not used the numbers of steps recommended by Tudor-Locke and Basett (2004) as they result from the 10,000 steps per day recommendation, which only 15% of the participants reached. Individuals in the low activity category have significantly higher values of body fat, higher BMI, WHR and WHtR and higher waist and hip circumference than those in the high activity category and a lower percentage of body water than in the high activity category ($p<0.05$). Similarly, individuals classified as having normal weight take significantly more steps per day than those classified as obese ($p<0.05$). Normal weight individuals take on average 7,740 steps per day in contrast to an average 6,219 steps per day in obese individuals (OBI-MO). We have not found significant differences in steps per day between normal weight subjects and those classified as underweight and overweight. This is consistent with the results of Tudor-Locke *et al.* 2001 but in contrast to Clemes *et al*. 2008, who also found significant results between the normal weight and the overweight categories.

These results support the role of physical activity as a preventive measure against the positive fat balance that may occur when individuals are exposed to high intakes of dietary fat (Blair 1993, Smith *et al.* 2000). However research results are also highly dependent on study design and its interpretation. The findings that a larger amount of physical activity is associated with healthier anthropometrics indices may be interpreted in three different ways. First, physical activity may really prevent weight gain; second, healthier anthropometrics measurements may lead to better exercise adherence; third, engagement in physical activity may be a proxy for a generally healthier lifestyle or psychological profile (better self-regulation) (Fogelholm, Kukkonen-Harjula 2000). A genetic effect on physical activity implies that not everybody is prone to engage in such activities (Maia *et al*. 2002), but speaking generally physical activity prescription for disease prevention might have potential value for public health research and recommendations (Eaton, Eaton 2003).

CONCLUSION

This study provides limited information currently available on the physical activity level of the adult Czech population. In the Czech Republic most studies involving questions of physical activity on the development of obesity are targeted at children (Pařízková 2008). To our knowledge this is the first study to examine the relationship between physical activity and body composition variables in the adult population in the Czech Republic. According to the results pedometer-determined physical activity seems to be a appropriate method for classification of physical activity. Based on monitoring 508 adult individuals in the present study, individuals with pedometer values lower than 5,102 steps per day were more frequently classified as obese than overweight or of normal weight. These individuals should be encouraged to increase their walking activity to approximate the number of steps taken by normal weight individuals (8,845±3,340). However, it is important to stress that not all individuals who took less than 5,102 steps per day were obese.

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