Original Article

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Physical Activity Measurement By SWA in Employees: Weekdays And Weekend

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Funds Collection

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Abstract

Introduction: *The purpose of this study was to identify the levels of physical activity level during the weekdays and weekend both female and male employees.* ***Method:*** *A total of 58 volunteer employees participated in this study of which 20 were male (M_{age} 32.50 ± 8.82) and 38 were female (M_{age} 34.24 ± 6.25). Anthropometric measurements were performed after an overnight fast for each participant. After anthropometric measurements, daily physical activity levels were measured continuously with the Sense Wear Armband (BodyMedia, USA) monitor, worn on the dominant arm triceps muscle on free-living individuals for a during of seven days. Whether the number of steps, physical activity level (PAL) and inactivity time change depending on the days of the week and the gender was calculated in repetitive measurements with one-way analysis of variance. For globosity variance validity, Mauchly's test was used. For the variables which cannot be replaced for globosity variance, Greenhouse-Geisser test was used.* ***Results:*** *According to daily step numbers, women are slight active and men are active (9479±3468; 11338±3297 step/day respectively) ($p>0.05$). Daily mean PAL is on sedentary/light level both for women and men (1.55±0.19; 1.61±0.28 $kcal \cdot kg^{-1} \cdot hr^{-1}$ respectively) ($p>0.05$). According to days of the week, a statistical difference was found between the daily step numbers in men and women ($p<0.05$). While there was a statistically significant difference in PAL averages among women ($p<0.05$), there was no statistical difference in men ($p>0.05$). While PAL value was the highest in weekdays and lowest on Sunday for both genders, the day with the longest inactivity time was found to be Sunday. Women`s daily mean inactivity time was founder to be longer than men (1264±69; 1205±107 $min \cdot day^{-1}$ respectively) ($p>0.05$).* ***Conclusion:*** *Both men and women take more than 10000 steps only in weekdays. PAL of both women and men in weekdays and weekend is at sedentary/light activity level. The most active days for both genders are in weekdays, while Sunday is the least active day.*

Keywords: *Gender, Physical activity level, Weekdays, Weekend*

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INTRODUCTION

Inactivity at work, home, transportation etc. increases more and more due to technological developments. This rise increases the prevalence of non-infectious chronic diseases such as obesity, coronary artery disease, hypertension, diabetes mellitus, and cancer. The role and importance of physical activity in prevention from these diseases is expressed in several researches [1,2]. Physical activity (PA) recommendations were published by WHO for protection and improvement of health [3]. These recommendations include weekly exercise period, numbers of daily steps or PAL. According to the recommendations of WHO, adults between 18-64 ages are recommended to do moderate activities for at least 150 minutes and or at least 75 minutes high intensity activities weekly. When the recommendations on the number of steps are discussed, according to Tudor-Locke and Basset [4], the steps are classified as sedentary if the number of daily steps is between 5000, as low level active if between 5000-7499 steps/day, slight active if between 7500-9999 step/day and active if between 10.000 and at high level active if more than 12500. According to 'Human Energy Requirements' report of FAO/WHO/UNU [5], PAL is classified as sedentary or light if 1.40-1.69, medium or active if 1.70-1.99, high level active if 2.0-2.40. According to socio-ecologic model; individual factors (age, gender, occupation etc.), social environment (family, workplace, life style, cultural background etc.), physical environment (weather condition, transportation, parks and geography etc.) and political factors (workplace policy etc.) influence the physical activity levels of individuals [6,7,8,9].

It is considered that the difference between physical activity levels apart from work between men and women can be affected from cultural structure of the society. While women in Turkey spend most of their times other than working hours at home and therefore taking care of housework more, men spend more time out of home than women in their out of work times. While women are dealing with food, dishes etc. housework in out of work times, men are dealing with shopping, taking kids to social or sport activities [10,11,12]. Activity level as per the days of the weeks are reviews in the researches carried out and it is specified that decrease in activity level particularly on Sunday may arise from necessity of resting before starting a new week or longer sleep duration [8,13].

Sense Wear Armband (SWA), which, to put it accurately, is a non-invasive device, provide information on lifestyle and measure physical activity patterns (intensity and duration of physical activity, total energy expenditure, active energy expenditure, average MET, number of steps per day, time sedantery, lying and sleeping) in free-living individuals [14]. In this study, it was aimed at reviewing physical activity levels, inactivity durations and the numbers of steps of employees by gender and days of the week by means of SWA, being and objective method.

METHOD

Subjects

Total of 38 female and 20 male who work at public institution. Healthy male and non-menopausal female employees participated in this study voluntarily after excluding chronic or acute health conditions that might affect ability to engage in physical activity. Study protocols were approved by the local Ethics Committee, and were conducted in a manner consistent with the institutional ethical requirements for human experimentation in accordance with the Declaration of Helsinki.

Anthropometric measurements

Standardized testing procedures were followed as defined in the American College of Sports Medicine Guidelines [15]. All anthropometric measurements were performed after an overnight fast on the first day from each participant. The participants were weighed while

wearing light clothes and without shoes. The weight was determined with TANİTA BC-418. The height was determined with measuring device to the nearest 0.1 cm. using a fixed wall-scale. The body mass index (BMI) was calculated as weight in kg divided by weight in meters squared for both female and male. In this study, assessment of Body Composition BC-418 8-contact electrode BIA system (Tanita Corp., Tokyo, Japan) was used to determine body composition. Body fat percentage, fat free mass (FFM), fat mass, basal metabolic rate (BMR) were obtained by using this device.

Physical activity measurement by multi sensor body monitor

The Sense Wear Armband (SWA) (BodyMedia, Inc., Pittsburgh, PA, USA) is a small (8.8 x 5.6 x 2.1cm) and light (82 g) multi sensor body monitor, worn over the triceps muscle of the dominant arm. It enables a continuous collection of various physiological and movement parameters through multiple sensors, including a two-axis accelerometer and sensors measuring heat flux, galvanic skin response, skin temperature, and near body ambient temperature. Data from these sensors are combined in a proprietary manner with gender, age, dominant arm, body weight and height, smoking habits, to estimate energy expenditure, PA intensity and number of steps, using algorithms developed by the manufacturer (SWA software, version 8.0). A valid day was considered a day with at least 1368 min of data, after imputation of known activities, which corresponds to 95% of a 24-hour period in this study [13]. Then, for each of 7 consecutive days, participants were instructed to wear the armband 24 hr/day^{-1} except for during water-based activities. Data were downloaded from the armband and then analyzed using SWA professional software. Energy expenditure, METs (metabolic equivalents expressed as kcal·kg·h^{-1}) values and steps were computed in 1-min intervals according to the manufacturer's algorithms. Eight variables were generate from the armband's software. Physical activity level (average daily METs) and energy expenditure (total kcal per day) were the indicators of the daily expenditure of energy. Step/minute were summed to obtain the total number of steps/day. All participants were asked not to make any changes to their typical daily work and leisure time routines during the monitoring week. In attempt to avoid possible Hawthorne effect subjects knew that they participated in a PA study and were monitored for their activity.

Statistical Analysis

The data are reported as means and standard deviations. Whether the number of steps, PAL and inactivity time change depending on the days of the week and the gender was calculated in repetitive measurements with one-way analysis of variance. For globosity variance validity, Mauchly's test was used. For the variables which cannot be replaced for globosity variance, Greenhouse-Geisser test was used. All statistical analysis was performed in SPSS version 20.0 and the level of statistical significance was set at $p<0.05$.

RESULTS

The descriptive statistics of the total study sample and physical and physiological characteristics of participants are shown in Table 1. According to Tudor-Locke and Bassett [4], daily numbers of steps of men is at "active" level and average of numbers of steps of women are at "*slight active*" level as per number of daily steps classification ($p>0.05$) . According to the classification of FAO/WHO/UNU [5], daily PAL average of both men and women is at "*sedanter/light*" level ($p>0.05$). Daily inactivity duration of both men and women including sleep is more than 20 hours and lying down duration is over 8 hours ($p>0.05$). The number of steps and PAL value are lower in women and inactivity duration is about 1 hour longer in women.

Table 1. Physical and physiological characteristics of employees

	Women (n=38) Mean ± SD	**Men (n=20)** Mean ± SD
Age (years)	34.24± 6.25	32.50 ± 8.82
Height (cm)	158.68 ± 5.84	176.40±6.46
Weight (kg)	60.97 ± 8.10	81.64 ±16.00
BMI (kg/m^2)	24.24 ± 3.13	26.15 ± 4.36
Fat (%)	30.24±5.52	19.48±6.94
Fat mass (kg)	18.74±5.70	16.82±8.81
FFM (kg)	42.12±3.23	65.02±8.84
BMR (kcal)	1291 ± 94	1923 ± 286

BMI=Body Mass Index; BMR=Basal Metabolic Rate; FFM=Free Fat Mass

Table 2. Physical activity parameters of employees.

	Women (n=38) Mean ± SD	**Men (n=20)** Mean ± SD	**Total (n=58)** Mean ± SD
STEP (number/day)	9479 ± 3468	11338 ± 3297	10120 ± 3496
PAL (kcal·kg^{-1}·hr^{-1})	1.55 ± 0.19	1.61 ± 0.28	1.57 ± 0.22
Lying Down (min·day^{-1})	490 ± 48	517 ± 64	499 ± 55
Sleep Duration (min·day^{-1})	405 ± 54	411 ± 57	407 ± 55
Inactivity (min·day^{-1})	1264 ± 69	1205 ± 107	1244 ± 88

Physical activity variables represent weekdays and weekend averages. PAL = Physical activity level

Table 3. Physical activity characteristics of different groups in weekdays and the weekend

	Weekdays Mean ± SD	**Saturday** Mean ± SD	**Sunday** Mean ± SD	F	p
Women					
Steps (number/day)*	10067 ± 3925	9178 ± 4812	7022 ± 4158	9.217	0.000
PAL (kcal·kg^{-1}·hr^{-1})*	1.58 ± 0.19	1.55 ± 0.24	1.48 ± 0.24	4.676	0.012
Lying Down (min·day^{-1})*	475 ± 76	544 ± 112	568 ± 96	10.492	0.000
Sleep Duration (min·day^{-1})*	391 ± 56	442 ± 91	462 ± 92	9.485	0.000
Inactivity (min·day^{-1})	1267 ± 74	1270 ± 82	1286 ± 95	1.028	0.383
Men					
Steps (number/day)*	12511 ± 4530	9415 ± 6077	9208 ± 4045	4.321	0.020
PAL (kcal·kg^{-1}·hr^{-1})	1.65 ± 0.26	1.60 ± 0.31	1.57 ± 0.34	1.102	0.343
Lying Down (min·day^{-1})	498 ± 94	492 ± 144	683 ± 435	3.079	0.058
Sleep Duration (min·day^{-1})*	410 ± 69	408 ± 141	492 ± 85	4.139	0.024
Inactivity (min·day^{-1})	1190 ± 123	1200 ± 152	1238 ± 142	1.322	0.276

Physical activity variables represent weekdays averages, calculated as the average of the 5 monitoring days. PAL = Physical activity level; *p<0.05.

There is a statistical difference between the averages of daily numbers of steps both in men (p<0.05) and women (p<0.05) by days of the week. The average of number of steps on weekdays is more than 10.000 steps both for men and women. According to the number of steps classification of Tudor-Locke and Bassett [4], women are "*active*" on weekdays, "*slight active*" on Saturday and "*low level active*" on Sunday. According to the same classification, men are "*highest level active*" on weekdays, and "*slight active*" on Saturday and Sunday. As per PAL classification

of FAO/WHO/UNU [5], women are active at "*sedentary/light*" level both during the weekdays and at weekend. However, there is a statistically meaningful difference between the days of the week in terms of daily PAL means ($p<0.05$). According to the same classification, men are active at "*sedentary/light*" level both during the week and at weekend and there is a not any statistically meaningful difference between the days of the week in terms of daily PAL means ($p>0.05$). PAL value is highest during the days of the week and lowest on Sunday in both genders. There is not any statistical difference between men and women in average of inactivity duration as per the days of the week ($p>0.05$). The day when inactivity duration is longest for both genders is Sunday.

DISCUSSION

As a result of the developments in technology, the growth in economics, the rate of urbanization and the other reasons, the prevalence of sedentary behavior and physical inactivity are more common in developed countries and also it is gradually becoming widespread in developing countries. Culture also one of the important factor for physical activity level [16]. This study assessed step count, physical activity levels and inactivity during the weekdays, saturday and sunday in female and male employees with SWA.

The total number of steps our study amounted as total to both female and males average 10120 step/day and is similar to the values average for the as found in the studies done by numerous authors. Macfarlane et al. [17] found that participants averaged 9839 steps day in Tokyo. De Cocker et al. [18] found that 9655 daily number of steps in Belgium. Miller and Brown [19] average number of steps 8873 step/day in working Australian adults that different from country to country. According to Tudor-Locke ve Basset [4] in this sample of workers a high level of steps was achieved. This situation may be originated from the residential area of our sampling group and their being healthy employees. Employees in Çorum maybe more active than those residing in other locations; for example, in some cases, when one participating office was not accessible with motorised vehicles such as by public transport, so employees could have done commute to work walking, cycling, or some combination thereof [20]. The reason for that is the province of Çorum is developing industrialization area with approximately about 250000 population and majority of people can go to work even on foot.

The effect of a physical activity component on gender demonstrated that women were much more sedentary than men [21,22]. According to the results from our study the average number of steps females 9479±3468 step/day, males 11338±3297 step/day. Thompson et al. [23] found that 8354 step/day in women. De Cocker et al. [18] found that 9428 in women and 9906 in men daily number of steps in Belgium. Unlike this research, Hirvensalo et al. [7] average number of steps in women is 7824; and 7089 in men in Finland. Miller and Brown [19] found that the average number of steps per day was 8543 for men and 9093 for women - values vary because of differences in age, sex, occupational, education, income, marital status, weather conditions, transportation, parks and life style [7]. Tudor-Locke et al., [24] stated that the number of steps varies between 4000-18000 steps/day in healthy adults.

According to numerous authors, the comparative studies of physical activity on both the weekdays and the weekend have shown that the numbers of step, the total physical activity during the weekdays were more than the weekend [7,13,20,25]. Our study in females the average number of steps is 10067±3925 during the weekdays, while this number falls Saturday 9178±4812 to Sunday 7022±4158. In addition to this, in males the average number of steps is 12511±4530 during the weekdays, while this number falls Saturday 9415±6077 to Sunday 9208±4045 step/day ($p<0.05$). According to classification of number of steps of Tudor-Locke and Basset [4], women are "active" on weekdays, "slight active" on Saturday and "low level active" on Sunday. As per the same classification, men are "high level active" on weekdays, and "slight active" on Saturday and Sunday. Similar to our study, Miller and Brown [19] found that,

the average steps was higher on weekdays than on weekend days. Smith et al. [20] found that 9682 step/day at weekdays and 9518 step/day at weekend. De Cocker et al. [18] state that Belgian adults' number of steps are 9755 step/day on weekdays and 9433 step/day at weekend ($p<0,05$). Hirvensalo et al. [7] state that 30-45 age Finnish adults take average 7712 step/day on weekdays and average 7048 step/day at weekend ($p<0.001$). Metzger et al. [26] investigated patterns of physical activity in the United States using an Actigraph accelerometer. Participants were categorized according to their patterns of activity. All classes demonstrated a decrease in moderate-to-vigorous activity on weekends, compared with weekdays, particularly pronounced decrease on Sunday. Matthews et al. [8], found that average differences in accelerometer measures across days of the week, time spent in physical inactivity was greater on Sunday compared with Saturday and on weekdays compared with weekend days. Especially, the physical activity of the participants had the lowest level on Sunday and this result is similar to the results from our study. It could be explained that the duration of time spent sleeping [27]. Our study sleeping time, Saturday females and males 442 $min \cdot day^{-1}$, 408 $min \cdot day^{-1}$; Sunday 462 $min \cdot day^{-1}$, 492 $min \cdot day^{-1}$ respectively) and lying down caused lower numbers of steps and an inactive life style during the weekend.

In our study, PAL value was found lower in women than men however there is not any statistical difference between PAL ($p>0.05$). Average inactivity duration of women is found to be 1 hour longer than men (1264±69; 1205±107 $min.day^{-1}$ respectively) ($p>0.05$). According to PAL classification of FAO/WHO/UNU [5], both genders are active on "sedentary/light" level both during week days and weekends. PAL value of both genders is highest on weekdays and lowest on Sunday; and the day when inactivity duration is longer is Sunday. The our findings show that the measured level of PA 1.55 MET in women and 1.61 MET in men. According to Tudor-Locke and Basset [4], although both men and women are within "slight active" and "active" categories according to number of steps, low level of PAL can be explained with the degree of the exercise. Similar to our study, by Scheers et al. [13] reported that although participants can be classified as "active" in terms of number of steps, their PAL level was found as 1.69 MET for men and 1.59 MET for women; and 1.64 MET in average. Besides Can et al. [28] reported that the number of number of steps counted with SWA is 10941 step/day for women and PAL value is 1.45 MET. Tudor-Locke et al. [24] recommended that despite some inter-individual variation, 100 steps/minute represents a reasonable floor value indicative of moderate intensity walking. Not only is the daily accumulation of PA important, but the intensity of the exercise as well. Incorporating at least 30 minutes, or approximately 3,000-4,000 steps, of brisk walking should be emphasized with the promotion of any step-based recommendation, in line with public health guidelines' focus on time in moderate vigorous physical activity (MVPA). Smaller increments (1000 steps, equivalent to 10-minute bouts) could also be used to track progress on either the individual or population level [24]. One of the actors influencing inactivity is gender, and other one is culture [1,29,30,31]. In our study, low level PAL values may arise from the difference between the duration of participation of women and men to PA domains. With the effect of culture, the activities of women and men during out of work time vary. Women in Turkey spend most of their out of work time at home and thus they are dealing with housework, while men are spending more time out of home when they are not at work. This may arise from the fact that while women are engaged with housework as meal and dishes etc. out of work times, men spend more time out of home due to the reasons as shopping and taking children to activities [10,11,12].

CONCLUSION

In conclusion, both men and women take more than 10.000 steps only on weekdays. The average of number of daily steps of women for 7 days is under 10.000 steps. Daily average PAL value of both men and women on weekdays and at weekend is at "sedentary/light" activity

level. The most active days are weekdays for both genders while Sunday is the least active one. Even though there is not any statistically difference between genders in terms of the number of daily steps, PAL and inactivity duration averages, men have higher averages than women. We suggest that necessary interventions shall be carried out by targeting development of strategies directed on increasing the level of activity of women particularly at weekend and increasing the PAL levels of both genders from sedentary level to active level basing on the findings of this research (especially in a moderate vigorous intensity in order to maintain a healthy and high-quality social and work life). Future studies for PA assessment might focus on the different age of subjects, their sex, and their occupation groups with objective physical activity measuring tool. The assessment of the physical activity of the workers in free-living conditions is really important not only for themselves but also for the future of their society.

Strengths and limitations of the study

The Sense Wear Armband- multi sensor body monitor non-stop for a week. The limitation of this work is a relatively low number of respondents. Also, the group included only healthy female and male employees (after excluding chronic or acute health conditions and pregnancy) which enabled the study to analyze only typical habitual physical activity not affected by health or age related issues. The evaluations are carried out over daily total activities and not reviewed as per sections/hours (work, out of work, house etc.) of the day. It should, however, be mentioned that the study group consisted of volunteers who agreed to wear. This may have led to a selection bias and an overestimate of physical activity levels because relatively active people might be more interested in this type of study.

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