ISSN 2282-0930 • Epidemiology Biostatistics and Public Health - 2023, Volume 18, Issue 1

Using accelerometer Analysis to Assess Physical Activity and Sedentary Behavior in Syrian Adults

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SUMMARY

Background: Overweight and obesity has become a serious public health problem in the world. Changes in daily physical activity (PA) levels may help moderate the health risks of sedentary behavior (SB). The aim of the present study was to determine PA and SB by triaxial accelerometer (ActiGraph GTX3 GT3X+, ActiGraph, Pensacola, FL. 32502 USA) in Syrian adults that affected by age, marital, body mass index (BMI), education, and smoking status.

Methods: We used cross-sectional baseline data from 97 participants of adults (18-60 years). Subjects wore an accelerometer for 7 consecutive days. Magnitude counts/minute was extracted to determine time in inactivity, in low-intensity, moderate, and vigorous-to-very-vigorous activity.

Results: Higher age was associated with more time in all categories of PA (light, moderate vigorous MVPA with bouts, MVPA without bouts, and step per day), while higher BMI was related to less time in PA, overweight/obese subjects, on daily average, spent less, but not significantly, time standing and little more time spent in sitting than the normal weight groups. Participant comparing to non-smoking peoples tended to spent less time in PA; however, this synchronization was not considerable.

Conclusion: Finally, our investigation demonstrated a positive synchronization between sedentary time and educational level. In this cohort of adults, most of men and women fulfilled the WHO recommendations. The levels of PA in 18–60-year-old adults are similar to previous data reported in adults.

Keywords: accelerometer; physical activity; sedentary behavior; Syria.

INTRODUCTION

Several urgent calls to action have been done to combat that the international physical activity (PA) and sedentary behavior (SB) [1]. Low PA is associated with an increased risk of morbidity and mortality. While, participation in regularly PA is well documented in the public health benefits across the life course [2].

Recent epidemiological studies have assessed the relationships between health risk associated with overweight or obesity and sedentary behavior (SB) status [3]. Regular physical activity (PA) is associated with good health [4]. In particular, SB and a lack of PA has been found to be associated with numerous health diseases, and considered to be an important burden in public health and is a health risk factors [5,6]. Published report classified the impact of PA as similar to that of smoking in relation to the risk of non-communicable diseases globally [7].

According to the WHO guidelines on PA and SB; the recommended amount of PA that adults should engage in at least 150-300 minutes per week of moderate PA, at least 75-150 min per week of vigorous PA, or an equivalent combination of the two recommendations listed above to prevent non-communicable diseases [8].

Accurate measurement of PA patterns (duration, frequency and intensity) is demand for effective intervention of non-communicable chronic diseases prevention programmers [4]. PA is difficult to determine

DOI: 10.54103/2282-0930/20755
Accepted: 21th March 2023

in population based health survey. Presently, several objective and subjective self report instruments are available for measuring PA in the population [9]. Objective assessments, such as pedometer, that count steps, and accelerometers, that determine movement intensity have been commonly used technique to measure PA levels has been successfully used in large scale epidemiological studies in different human generations [10,11]. To date, the majority of researches has focused on PA towards in developed countries and has indicated in the literature gape concerning PA in developing countries, where the type of activities performed differ from those taking place in high income settings [12].

Equipment's have been improved and procedures have been used to report situations in previous scientific research. To date, no studies have examined the Syrian situations using these devices. There is currently limited or no information about the feasibility and precision in Syria. However, there is abundant literature on the advanced analytical methods to assess PA behavior using accelerometer time series on other populations [13]. This information would be particularly useful for clinicians and researchers when deciding this instrument to chose. Therefore, The objective of this work was to determine the synchronization of SB and intensity of PA with age, marital status, BMI, education level and smoking among adult men and women using objectively assessed data on PA and SB in Syrian adults.

MATERIAL AND METHODS

Study design and sample recruitment

This was an observational cross sectional designed study. During 2020-2021, a sample of 121 participants were randomly selected from several workplaces in Syrian Atomic Energy Commission (SAEC). In total, 97 had valid accelerometer measurements. Participants were required to be between the ages of 18 and 60 years. Participants were eligible for this study if they were willing to wear AG accelerometer for 7 consecutive days and were willing to complete surveys in Arabic language. Each participant provided informed consent prior to participation after a detailed explanation of the study protocol. The Atomic Energy human ethics committee approved the study protocol. It was excused in accordance with the regulation prescribed by Helsinki Declaration of the world Medical Association.

All subjects with complete data on objectively assessed PA, height and weight were included in the current analyses. Height and weight in light clothing were determined to the nearest 0.5 cm with a wall-mounted stadiometer (Seca, Model: 225 1721009; Germany), and to the nearest 0.1 kg with electronic digital scales (Seca, Model: 7671321004; Germany), respectively. From these measurements the body mass index (BMI) was calculated as weight (kg) divided by height (m) squared (BMI, in kg/ m^2).

Accelerometer processing

A triaxial accelerometer (ActiGraph GTX3 GT3X+, ActiGraph, Pensacola, FL. 32502 USA) was used to assess PA for the participants with four to seven days in this study. The device was initialized to collect data on PA, including activity counts, energy expenditure (kcal), steps, and activity intensity as metabolic equivalents (METs) [5]. Participants were advised to wear the accelerometer on the right left hip for seven consecutive days during waking hours excluding contact sports, washing, bathing, swimming or sleeping activities [14]. Subjects were asked to remove the device before aquatic activities such as showering, swimming or bathing. The AG accelerometer data was processed using AG ActiLife 6 software, and exported to Microsoft Excel format. Within Microsoft Excel, minutes of PA, including light, moderate and vigorous and SB on valid days (≥10 hours of wear time) were summed and divided by the number of valid days of wear time to create a daily average equivalent activity. ActiLife 6 software to initialize the accelerometer and to download results, raw data was converted with Freedson cut points [15]. PA intensity levels refers to how hard your body is working during PA, and defined as that person's total energy expenditure (TEE) in a 24-hour period by his or her basal metabolic rate (BMR). Average daily time in moderate to vigorous physical activity (MVPA) (min/day) and SB (min/day) were calculated [16]. The daily average was multiplied by seven to create a weekly total [9].

Statistical analysis

Differences in PA and SB levels between adult's women and men were analyzed using Student's t-test, and differences according to the ages, marital status, BMI, education level, and smoking statues were analyzed using paired-samples t-test using Fisher's one-way ANOVA. In cases of unequal variances, Welch's ANOVA was used. All analyses were performed using Statistical Package of Social Science (SPSS) (Version 17.0.1, 2001 24, 2016, SPSS Inc., Chicago, USA) and all values of $p < 0.05$ were considered statistically significant.

RESULTS

Participant characteristics

The overall and sex specific characteristics of the participants (N = 97) are indicated in Table 1. Most of participants were women (n= 67, 69.1%). The average

age (SD) of participants ranged from 36.4 (±8.7) years among women to 44.3 (±6.9) years among men. A total of 97 individuals (30.9% males; 69.1% females) with a mean age of 38.9 years (SD = 8.9) participated in the study. Out of 97 participants, 25 (25.8%) were singles, and 72 (74.2%) were married. The mean BMI was 27.6 kg/m2 (SD = 4.7), BMI = 28.8±3.3 kg/m^2 for men, and 27.1±5.2 kg/m2 for women. The majority of the subjects were overweight, as 69.1% (n=67) were classified as overweight or obese. As for education status, 12(12.4%) were lower education (< secondary school), 17(17.5%) were moderately at education (secondary school), while 68 (70.1%) declared having a higher education levels (> secondary school).

Overall physical activity

Means and standard deviations for the accelerometer variables are presented in Table 2. The participants accumulated a total average daily sedentary behavior, light PA, moderate PA, and Vigorous PA time of 644.2 min/day (10.74 hours), 196.0 min/day (3.27 hours), 41.0 min/day (0.68 hours), 1.0 min/day (0.02 hours), respectively. The MVPA is 7.3 min/day (0.12 hours) with 10 min bouts, and 42.0 min/day (0.70 hours) without 10 min bouts. Participants accumulated a mean of 7502.2 steps per day. There were only slight, non-significant differences between male and female in time spend sedentary or in light PA (Table 2). Men accumulate more minutes of moderate, vigorous, MVPA with 10 min and , MVPA without 10 min bouts than women ($p<0.05$). Also, men accumulate more steps per day than women ($p<0.001$).

Physical activity levels by age, marital status, BMI, educational level and smoking status

All physical activity measures were positively associated with age. While sedentary behavior was inversely associated with age. The associations were significant ($p<0.05$) only for light and vigorous PA (Table 2).

Sedentary behavior, light PA, Moderate PA, Vigorous PA, MVPA with bouts and MVPA without bouts were not associated with marital status, BMI, education level and smoking ($p>0.05$) (Table 2).

Step per day were inversely synchronization with education levels ($P<0.05$). There were no differences in accumulated step per day between ages marital status, BMI values, and smoking (Table 2).

Meeting recommendation

According to the global WHO recommendations for PA, 88.7%. of adults (95% CI: 80.6 – 94.2%) (85.1% of women (95% CI: 82.8 – 99.9%) and 96.7% of men (95% CI: 74.3 – 92.6%)) accumulate 150 minutes per week of MVPA without 10 minute bouts, while 3.1% of adults (95% CI: 0.6 – 8.8%) (1.5% of women (95% CI: 0.8 – 22.1%) and 6.7% of men (95% CI: 0.0 – 8.0%)) accumulate 150 minutes per week of MVPA with 10 minute bouts. The same trend was indicated for the age groups (Figure 1).

According to the proportion fulfilling the global WHO recommendations for step count of 10.000 steps per day, 88.7% of adults accumulate < 10.000 step per day (73.3% for men and 95.5% for women), and 11.3% of adults accumulate > 10.000 step per day (26.7% for men and 4.5% for women). The same trend was indicated for the age groups (Figure 2).

DISCUSSION

This study reports cross-sectional associations between PA and SB that measured by objective method which the accelerometer, in a group of adult subjects of both sexes age 18–60 yr. The accelerometer data are the first objective measurements of PA and SB in a nationally representative survey. However, the absolute count, duration results from the accelerometer data provide a new and a real picture of PA in the Syrian population. Accelerometers are widely used for estimation determining PA in free living conditions. The accelerometer provides an estimate close to truth, and that respondents greatly overestimate their PA [17].

The World Health Organization (WHO) recommendation is to practicing at least 150 min per week of moderate-intensity or 75 min per week of vigorous-intensity aerobic PA per week, or an equivalent combination of both type of PA, for people aged from 18 to 64 years [8,18]. National and international guidelines recommended 30 minutes or more of moderate intensity PA daily (at least five day a week), or vigorous intensity PA for at least 20 minutes and three day a week [19]. However, in assessed Syrian group the moderate intensity PA is high (40 min per day) While, the vigorous intensity PA is low (only 1 min per day). The lack of PA may contribute to the deteriorations in health observed among this population.

The most important finding in this study is that 88.7% of Syrian adults are meeting the normal PA recommendation (accumulate 150 minutes per week of MVPA without 10 minute bouts). When activity in bouts of 10 minutes was considered, adherence prevalence estimates were 3.1% among adults. A considerable amount of the evidence in support of the 150-minutes-per-week recommendation suggests that frequent PA is important for health [19]. Recently, based on data from accelerometer, the revised United States recommendations for PA omitted the requirement that MVPA should be performed in at least 10-minute bouts [20].

Our results, in agreement with previous studies, may support the opinion that meeting the recommended PA could may not be sufficient if sedentary time is not

reduced [21, 22]. It has been recommended that SP SB could be an independent determent of health risk [23].

Objectively measured PA data show that 3% of Americans aged 20 to 59 years accumulating at least 30 minutes of MVPA in 10 minute bouts on 5 out of 7 days [24]. Canadian date, also show that 6% for the same age range accumulating at least 150 minutes a week of MVPA in 10 minute bouts [25]. The low prevalence of adherence to the WHO PA suggestion is comparable to other European studies. In Germany only a median of 14% of MVPA was aggregated in bouts of at least 10 minutes for the testing group (N = 475), aged 48-68 years [24]. In Norway, 20% of the study participants aged 20±85 years, aggregated at least 30 minutes of daily MVPA in bouts of 10 minutes [26]. In Swedish subjects (age range 18-79 years), only 1% reached 30 minutes/day in pout of 10 minute bouts [28]. In Portugal, 3-7% participants aged 40-64 years aggregated at least 30 minutes MVPA/day in periods of at least 10 minutes [29]. In Norwegian adults and elderly, 22% fulfilled the current global recommendation for PA. However, when counting all accumulated non-bouted MVPA, the proportion increased three-fold, to 70% [30].

Our results show that 11.3% of Syrian adults (men and women) achieved the 10.000 steps per day. The average adults ranged from 6.9661 to 9.277 steps per day. These figures are close to other results, which showed that American adults accumulated about 9,700 steps per day [24]. For Canadian adults the average man takes approximately 9,500 steps per day, and the average woman, 8,400 steps. [25].

Males are generally more active than females, and PA is higher in older age groups. However, the mean count, duration, and adherence prevalence results from the accelerometer data provide a new picture of PA and SB in the Syrian population; by ages 18–60 yr, mean levels of moderate activity are low, and vigorous activity is almost nonexistent. The light levels of PA are particularly evident when bouts of activity are considered. Our findings suggest that men and women spend same time in what might be considered low or sedentary levels of PA, while men spend more time in moderate and vigorous levels of activity. In previous experiments, male subjects participants in studies from Germany [26], Norway [31], Portugal [32], the United States [32], and the United Kingdom [33] aggregated more minutes of MVPA than female participants.

With respect to age, we observed small differences in the summary measure of PA by age. Higher age was related to more time in light, moderate vigorous MVPA with bouts, MVPA without bouts, and step per day. These differences by age group are in contrast to other population-based studies [34] that have used hip worn accelerometers.

Unexpectedly, our investigation found no significant difference in sedentary time and PA (light, moderate, vigorous, MVPA with bouts, MVPA without bouts, and step per day) between normal weight and overweight/obese groups. However, the results of this study support the hypothesis that obese or overweight participants, on daily average, spent less, but not significantly, time standing as MVPA, and little more time sitting than the normal weight groups. These results are comparable to the study conducted by Schaller et al. [35], who also found no significant difference in standing and sitting time between normal and overweight participants. Jaeschke et al. [36], who did not find as association of BMI with other activity intensities. Previous study illustrated that normal and obese participants spent approximately the same amount of time for lying down [37]. Several studies support the hypothesis that obese participants spent less standing time and more sitting time than normal or overweight groups [3]. Additionally, higher BMI was associated with less time spent in low intensity activity [38], which may be explained by the fact that BMI is strongly correlated with body weight [35]. The obese individuals spending more sitting time (using the computer or watching TV) compared to normal weight or overweight groups [36]. The relative instability of SB and PA time in-between normal and obese participants need more studies for confirmation.

Our analyses suggested differences by education levels when assessing by accelerometer. Our study demonstrated a positive association between sedentary time and educational level, which is consistent with studies from other countries [39]. Also, our results demonstrated a negative association between PA and educational level, which is in contrast with studies from other countries [40,41]. Individuals with lower education are more likely to possess jobs including standing and walking, usually of light intensity PA [42].

Current smokers spent less time in moderate and vigorous activity and more time in low intensity [43]. Additionally, smoking is often related to a generally less healthy attend lifestyle including lower sports and exercises behavior [44]. Thus, one may conclude that smoking has a long-term effect on intensity of individual PA. This assumption is supported by our founding that participant compared to never smokers tended to spent less time in PA; however, this association was not statistically significant.

Strengths of the study

This study had several strengths, beginning with the adherence to standardized WHO protocols in administering accelerometer, and the concordant measurement period (7days) for the accelerometer employ standardized WHO [8] protocols in estimating PA and the concordant measurement period (7days) for the accelerometer. Strength of this study was the focus on participants under free-living conditions. Also, our study has strength that we objectively measured PA levels and SB time using a triaxial accelerometer for the first time in Syria.

ISSN 2282-0930 • Epidemiology Biostatistics and Public Health - 2023, Volume 18, Issue 1

Limitations of the study

We only included wake time data; therefore, limitation was that sleep period was excluded from the data collected and processes. New findings supports that sleep period and sleep disorders may negatively affect of health outcomes [45]. The study population, consisting of predominantly participants of higher socioeconomic situations and healthy adults, is not representative of the general population. It is not possible to confirm that these results are representative of the wider male and female population residing in Syria. Further works are required using larger samples of population from multiple Syrian regions.

Moreover, the accelerometer cut-points for categorizing the intensity of PA may be population-specific and not appropriate for Syrians. However, the classification of PA intensities by using accelerometer information is also affected on the cut points used [46].

CONCLUSION

This study is one of the first to use the accelerometer function-measured time spent in standing, and sitting postures among diverse samples of adults from different gander, wide age range, different education statues, different BMI, and smoking or not smoking participants of Syrian adults, showed moderate validity of the long IPAQ when compared to accelerometer data with correlations in a similar range as reported in other studies.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

ACKNOWLEDGMENTS

The authors wish to express their deep appreciation to the Director General of AECS.

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Table 1. Descriptive characteristics of the participants.

Variables	Subcategory	Total sample	Men	Women
		(N=97)	**(n=30, 30.9)**	**(n=67, 69.1)**
Age (years)	Mean (±SD)	38.9±8.9	44.3±6.9	36.4±8.7
Age group (n, %) *	18-29	17 (17.5)	0 (0.0)	17 (25.4)
	30-45	55 (56.7)	16 (53.3)	39 (58.2)
	>45	25 (25.8)	14 (46.7)	11 (16.4)
Marital status (n, %) *	Single	25 (25.8)	2 (6.7)	23 (34.3)
	Married	72 (74.2)	28 (93.3)	44 (65.7)
BMI (Kg/m2)	Mean (±SD)	27.6±4.7	28.8±3.3	27.1±5.2
BMI Category (n, %) *	Normal Weight	30 (30.9)	4 (13.3)	26 (38.8)
	Overweight/Obese	67 (69.1)	26 (86.7)	41 (61.2)
Educational level (n, %)	< Secondary School	12 (12.4)	5 (16.7)	7 (10.4)
	Secondary School	17 (17.5)	8 (26.7)	9 (13.4)
	> Secondary School	68 (70.1)	17 (56.7)	51 (76.1)
Smoking (n, %)	Yes	41 (42.3)	16 (53.3)	25 (37.3)
	No	56 (57.7)	14 (46.7)	42 (62.7)

*Significant difference exists between men and women at p<0.05
BMI: Body Mass Index
N: number of subjects

Table 2. Descriptive intensity of activity and step counts, by sex, age, marital status, BMI, education and smoking; Mean (SD).

		intensity of activity						
Variables/Subcategory	**N**	**Sedentary**	**Light**	**Moderate**	**vigorous**	**MVPA with bouts**	**MVPA without bouts**	**Steps per day**
		Minutes per day (mean (SD))						**Average**
Sex								
Total	97	644.2 (90.7)	196.0 (40.8)	41.0 (19.7)	1.0 (1.3)	7.3 (10.9)	42.0 (20.1)	7502.2 (2513.2)
Women	67	641.0 (89.7) [a]	193.8 (44.1) [a]	35.5 (14.5) [a]	0.8 (1.1) [a]	5.5 (8.1) [a]	36.3 ± (14.9) [a]	6904.1 (2111.3) [a]
Men	30	651.3 (94.0) [a]	200.7 (32.5) [a]	53.2 (24.0) [b]	1.5 (1.7) [b]	11.5 (14.9) [b]	54.7 (24.3) [b]	8838.0 (2844.4) [b]
Age (years)								
18-29	17	670.6 (136.9) [a]	175.6 (41.4) [a]	36.3 (12.0) [a]	0.9 (1.0) [a,b]	6.1 (10.9) [a]	37.2 (12.3) [a]	6966.9 (1791.9) [a]
30-45	55	629.7 (68.6) [a]	198.3 (40.6) [b]	39.5 (15.5) [a]	0.9 (1.1) [a]	6.1 (8.1) [a]	40.3 (15.8) [a]	7449.8 (2201.4) [a]
>45	25	658.2 (93.0) [a]	204.7 (37.9) [b]	47.5 (29.0) [a]	1.5 (1.8) [b]	9.7 (15.7) [a]	49.0 (29.6) [a]	7981.4 (3430.9) [a]
Marital status								
Single	25	659.8 (116.4) [a]	186.5 (44.1) [a]	41.0 (14.6) [a]	1.1 (1.4) [a]	8.7 (10.6) [a]	42.1 (15.1) [a]	7888.7 (2424.8) [a]
Married	72	638.8 (80.2) [a]	199.3 (39.4) [a]	41.0 (21.2) [a]	1.0 (1.3) [a]	6.9 (11.1) [a]	41.9 (21.7) [a]	7368.0 (2545.9) [a]
BMI (Kg/m2)								
Normal Weight	30	646.1 (111.2) [a]	199.7 (51.7) [a]	45.3 (16.0) [a]	1.0 (1.2) [a]	8.3 (9.5) [a]	46.3 (16.1) [a]	7960.7 (2468.2) [a]
Overweight/Obese	67	643.4 (80.8) [a]	194.3 (35.2) [a]	39.1 (20.9) [a]	1.0 (1.4) [a]	6.9 (11.6) [a]	40.1 (21.5) [a]	7296.9 (2524.3) [a]
Educational level								
< Secondary School	12	599.5 (71.5) [a]	205.0 (35.0) [a]	53.4 (18.7) [a]	1.4 (1.4) [a]	11.3 (9.6) [a]	54.7 (18.9) [a]	9277.0 (3280.0) [a]
Secondary School	17	644.7 (88.0) [a]	191.7 (34.4) [a]	39.0 (18.3) [a,b]	1.2 (1.5) [a]	6.3 (7.3) [a]	40.1 (19.0) [a,b]	7032.1 (2695.0) [b]
> Secondary School	68	652.0 (93.1) [a]	195.5 (43.4) [a]	39.3 (19.6) [b]	1.0 (1.3) [a]	6.9 (11.8) [a]	40.2 (20.0) [b]	73.6.5 (2211.4) [b]
Smoking								
Yes	41	633.0 (75.0) [a]	205.0 (35.0) [a]	41.0 (21.0) [a]	1.3 (1.6) [a]	6.0 (7.2) [a]	42.3 (21.6) [a]	7499.9 (2563.6) [a]
No	56	652.4 (100.5) [a]	195.7 (38.6) [a]	40.9 (18.8) [a]	1.0 (1.1) [a]	8.3 (13.0) [a]	41.8 (19.1) [a]	73.6.5 (2499.0) [a]

* Significant difference< 0.05
SD: standard deviation
BMI: Body Mass Index
N: number of subjects

ISSN 2282-0930 • Epidemiology Biostatistics and Public Health - 2023, Volume 18, Issue 1

Figure 1. The proportion of women, men, total and by age groups, fulfilling the WHO's recommendations for physical activity of 150 minutes of MVPA per week, in both non-bouted and bouted MVPA.

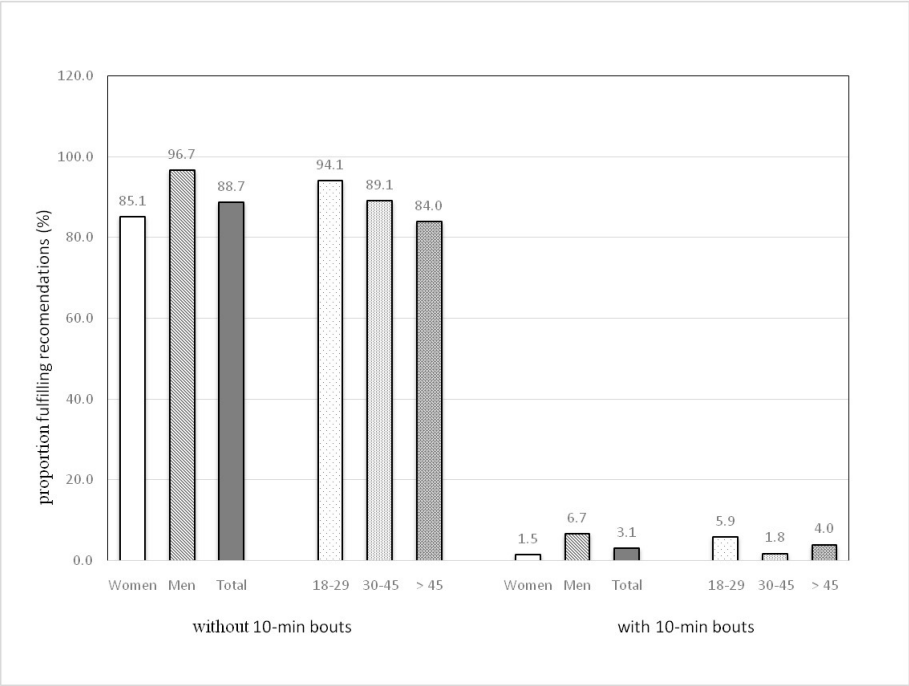

Figure 2. The proportion of women, men, total and by age groups, fulfilling the WHO's recommendations for step counts of 10000 steps per day