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The Seasonal Variations of Energy Expenditure and Physical Activity in Turkish Older Adults

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ABSTRACT

Objective: Regular physical activities contributes to better health outcomes in all stages of life. Older adults may have altered levels of exercise at different times of the year.

Methods: Community-dwelling older adults (≥65 years of age) in Ankara, is the capital city of Turkey were recruited prospectively. Physical activity status and the resting metabolic rate were assessed every three months (May, August, November, and February).

Results: Overall, 31 individuals were analyzed (mean age women: 73.9±7.0 years, men: 75.5±5.7 years; women: 65.0%). The level of physical activity was highest in autumn (44.0±41.0 min) and summer (41.0±48.0 min) but lowest in winter (24.0±19.0 min) (p<0.05). The ratio of performing regular daily exercise was highest in summer (25.8%), which decreased significantly in winter (9.7%). No statistically significant changes were noted in the total daily energy expenditure and resting metabolic energy expenditure across four seasons.

Conclusion: Although some increases were observed in autumn and summer, the level of physical activity in older adults was low in all seasons. However, daily energy expenditure remained constant. The study suggests that there is a need for improvement in lifestyle behaviors of Turkish older adults to increase health-related quality of life and also to prevent adverse outcomes.

Keywords: Older adults, Seasonal changes, Physical activity, Resting metabolic energy expenditure.

1. INTRODUCTION

People worldwide are living longer, and the world's population aged 60 years and older is increasing (1,2). According to the World Health Organization, between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22% (2). Therefore, improvement of health and quality of life are critical, particularly for the aged individuals (1). Regular physical activity and exercise have been shown to improve not only the physical and mental health but also the quality of life in older adults (3).

Seasonal variations are among the critical environmental factors that have strong influences on duration and frequency of physical activities at certain times of year (4,5). Studies have shown that the level of physical activity is dependent on winds, rainfall, and altered humidity (6). In general, older adults are more physically active in summer and spring, but they slowdown in winter mainly because of extreme cold, slippery ground and shorter daytime (7). While evaluation of physical activity in older adults needs consideration of seasonal changes, lifestyle habits including eating and doing exercise in the old age may be dependent also on adulthood behaviors, cultural infrastructure, and financial situation. Thus, information collected from a population may not be valid for another. The present study aimed to assess the level of daily exercise and energy expenditure in a group of Turkish older adults. First hypothesis of this study is; Physical activity level and energy expenditure of older adults can be affected by seasonal changes. Other hypothesis of this study is; Turkish older adults should be more active in spring and summer, but more inactive in winter.

2. METHODS

In this single-center, prospective, non-interventional study, we enrolled subjects aged 65 years or older living in the capital city Ankara, Turkey. Inclusion criteria were; having sufficient cognitive and functional skills to adapt the study procedures, residing in the same region at least for three years, and signing the informed consent. Exclusion criteria were being bedridden, having memory and speech disorders, cancer, traumatic disease, arthritis, arm injury, or neuromuscular disorders. All participants underwent cognitive testing by the mini mental state examination test (8).

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The ethics committee of Gülhane Military Medical Academy, Turkey, approved the study protocol (13/1648.4-1242) and all participants gave written, informed consent.

The data were collected between May 15, 2013, and November 30, 2014, and planned four periods of observation; spring (May), summer (August), autumn (November) and winter (February) in this study. Basic characteristics were recorded using a questionnaire. At each season, the level of physical activity and energy expenditure were measured for three consecutive days, one of which was a weekend day. Participants were specifically informed about remaining on their routine and doing no additional physical exercise before or during the time of data collection.

The average frequency of regular exercise and physical activity (no less than 30 minutes per session) were recorded using a scale which included the following choices: none, once a week, twice a week, three times a week, and daily. Resting metabolic rate (RMR) is the total number of energy consumption when your body is completely at rest, was measured with a desktop metabolic monitor (*Fitmate Pro, Cosmed, Italy*) in the summer and winter (9). Physical activity status was determined using the armband (*Sensewear armband, BodyMedia Inc., ABD*) which is a validated, objective method to assess the physical activity (5,10). Duration of lying down (h), duration of physical activity (min), total energy expenditure (kcal/day), number of steps and average METs values through the three days were taken with the armband, and average values were calculated. METs values that show exercise intensity were classified as light (< 3.0 MET), moderate (3.0–5.9 MET) and vigorous (> 6.0 MET) (11).

Continuous variables were presented as the mean and standard deviation. Categorical data were presented as the absolute number and percentage of the total. Non-normal distribution was tested by the Shapiro-Wilk test. Seasonal changes in numerical values were calculated by the Friedman test and Wilcoxon Rank test. The differences in qualitative data on different seasons were tested by the Cochran's Q test, and McNemar test. Statistical significance was accepted at p<0.05. All analyses were performed using SPSS (PASW) 23.0 software (SPSS Inc, Chicago, Illinois).

3. RESULTS

Forty-three individuals initially were enrolled but two of them died during the study, and another ten withdrew consent. Among the 31 subjects analyzed, 20 (65%) were women, and mean age was 73.9±7.0 years old for women and 75.5±5.7 years old for men.

According to the physical activity questionnaire, 48.4% of the participants had regular exercise in summer, 41.9% in autumn, and 35.5% in both spring and winter. All of the participants doing regular exercise preferred walking to other types of physical activity. The frequency of performing regular physical activity in winter, spring, summer, and autumn was 54.5%, 63.6%, 81.8% and 72.7%, respectively among men; and 25.0%, 20.0%, 30.0% and 25.0%, respectively among women. We found no statistically significant difference in regular physical activity across seasons in both men and women. The percentages of did exercise twice a week, were found highest (22.6%) in whole group, also only 9.7% exercised in winter. Exercise frequency increased in summer and autumn (25.8% and 19.4%, respectively). In summer, the frequency of daily physical activity increased in women, but it was not statistically significant. In winter, 18.2% percent of men had daily physical activity, which increased to 54.6% in summer and to 45.5% in autumn. Seasonal changes in exercise frequency were more prominent among men by this was also not significant (p>0.05) (Table 1).

Table 1. *Exercise frequency according to season in older adults*

Exercise frequency	Winter		Spring		Summer		Autumn	
Men (n=11)	n (%)		n (%)		n (%)		n (%)	
Daily	2 (18.2)		3	27.3	6	54.6	5	45.5
1/w	-	-	-	-	-	-	-	-
2/w	3	27.3	2	18.2	1	9.0	1	9.0
3/w	1	9.0	2	18.2	2	18.2	2	18.2
None	5	45.5	4	36.3	2	18.2	3	27.3
Women (n=20)								
Daily	1	5.0	1	5.0	2	10.0	1	5.0
1/w	-	-	-	-	-	-	1	5.0
2/w	4	20.0	2	10.0	2	10.0	2	10.0
3/w	-	-	1	5.0	2	10.0	1	5.0
None	15	75.0	16	80.0	14	70.0	15	75.0
Total (n=31)								
Daily	3	9.7	4	12.9	8	25.8	6	19.4
1/w	-	-	-	-	-	-	1	3.2
2/w	7	22.6	4	12.9	3	9.7	3	9.7
3/w	1	3.2	3	9.7	4	12.9	3	9.7
None	20	64.5	20	64.5	16	51.6	18	58.1

Mean duration of exercise across seasons is presented in Table 2. Men had more than 25 min longer daily exercise in summer than spring. Among women, the duration of exercise decreased in winter (28.0±4.5 min/day) and increased in summer (42.5±24.0 min/day). The duration of exercise increased in summer in both men and women. The duration of daily exercise in the total sample was 42.7±20.4 min in winter and 43.6±14.2 min in spring, which increased to 60.0±40.1 min in summer and decreased to 46.2±17.8 min in autumn. None of these comparisons were significant statistically (p>0.05) (Table 2).

Table 2. *Seasonal exercise duration of older adults have a regular exercise period (min)*

Exercise duration	Winter	Spring	Summer	Autumn	p
	Mean±SD	Mean±SD	Mean ±SD	Mean ±SD	
Men (n=11)	55.0±20.5	47.1±13.5	71.7±45.5	50.6±19.5	0.392
Women (n=20)	28.0±4.5	37.5±15.0	42.5±24.0	39.0±13.4	0.392
Total (n=31)	42.7±20.4	43.6±14.2	60.0±40.1	46.2±17.8	0.330

**Wilcoxon Signed Ranks Test was used.*

Total daily energy expenditure and the duration of physical activity are presented in Table 3. According to the armband data, the duration of physical activity was higher in summer and autumn compared to other seasons, and it was significantly lower in winter (p<0.05). Mean daily step count in summer (4851±3708) was significantly higher than in winter (3685±2534) (p<0.05). Changes in the duration of seasonal physical activity and steps count were statistically significant by gender (p>0.05). Total daily energy expenditure showed alterations depending on the variations in the duration of physical activity. Mean daily energy expenditure was higher in summer (2228±380 kcal/day) and autumn (2187±351 kcal/day), respectively, and lowest in winter (2120±361 kcal/day). However, changes in daily energy expenditure were not statistically significant (p>0.05). Seasonal changes in the duration of resting and METs values were not significant in both genders (p>0.05). There were also no significant differences in RMR (kcal/day) across seasons (p>0.05) (Table 3).

Table 3. *Energy expenditure, physical activity status and duration of exercise in older adults according to season from armband database*

Energy expenditure and physical activity	Winter	Spring	Summer	Autumn	p
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Men (n=11)					
Lying down duration (h)	7.7±2.3	8.0±1.3	8.1±1.8	8.1±2.2	0.938
Physical activity duration (min)	32.0±23.0	48.0±53.0	61.0±68.0	68.0±57.0	0.138
Total Energy Expenditure (kcal/day)	2224±350	2228±336	2358±391	2380±469	0.301
Step Count	3816±2303	4406±3751	6013±5293	5144±3888	0.200
Average METs	1.1±0.1	1.2±0.2	1.2±0.3	1.2±0.2	0.464
Women (n=20)	**Winter**	**Spring**	**Summer**	**Autumn**	**p**
Lying down duration (h)	8.3±1.6	8.1±2.3	8.0±1.5	7.8±1.7	0.423
Physical activity duration (min)	19.0±16.0	34.0±50.0	31.0±28.0	30.0±21.0	0.117
Total Energy Expenditure (kcal/day)	2062±363	2153±410	2094±296	2145±303	0.884
Step Count	3613±2708	3364±1630	4212±2399	3975±2029	0.068
Average METs	1.1±0.2	1.3±0.6	1.1±0.2	1.2±0.2	0.125
Total (n=31)	**Winter**	**Spring**	**Summer**	**Autumn**	**p**
Lying down duration (h)	8.1±1.8	8.1±2.0	8.0±1.6	7.9±1.8	0.433
Physical activity duration (min)	24.0±19.0^{a}	39.0±51.0^{a}	41.0±48.0^{b}	44.0±41.0^{a,b}	**0.011***
Total Energy Expenditure (kcal/day)	2120±361	2179±381	2187±351	2228±380	0.459
Step Count	3685±2534^{a}	3734±2575^{a}	4851±3708^{b}	4390±2823^{b}	**0.008***
Average METs	1.1±0.2	1.3±0.5	1.2±0.2	1.2±0.2	0.095

a,b,c Values within row with different superscripts are significantly different, (p<0.05) Wilcoxon Signed Ranks Test.

4. DISCUSSION

Physical inactivity is the fourth most important cause of mortality in the world and is assumed to be responsible for the death of 3.2 million people annually. Regular mild physical activity (walking, cycling, etc.) has favorable influences on the health status of older adults (3,12). It is well-known that older people who are physically active have lower morbidity and mortality rates than inactive older people. Nevertheless, regular physical activity decreases progressively with age (13). The negative consequences of physical inactivity and sedentary behavior, such as prolonged sitting, among older people are also well established. Inactive lifestyle has been associated with mortality, decreased quality of life, and increased risk of chronic diseases such as cardiovascular disease, type 2 diabetes, obesity, cancer and depression (14-17).

In this study, seasonal variations in the level of physical activity and energy expenditure were examined. Although less is known in older adults, studies in adult populations have shown that climate or seasonal changes have profound effects on the basal metabolic rate, such that individuals living in mild climates have lower BMR (basal metabolic rate) than those who live in cold climates to maintain body size and composition (18-20). In an adult group, a 7°C decrease in ambient temperature caused a reduction in body temperature, development of tremors and an increase in RMR by 11.5% (21). A marked decline in temperature and subsequent cold exposure increases the energy required to restore tissue temperature. In older adults, a relatively larger body fat percentage protects the individual against the adverse effects of cold (22, 23). The study on indigenous and nonindigenous circumpolar groups of North America and Siberia has shown that the ecology and genetics of thyroid function may regulate metabolic rates (24). In this study, RMR energy expenditure changes were not significant statistically across seasons in both men and women. This finding was different from the literature because older adults did not generally leave the house in winter to protect themselves from the cold/rainy weather, slippery ground, or in summer to avoid the sun and hot weather. Accordingly, Umemiya et al. reported that the use of air-conditioners might have favorable influences on RMR (25). Also, Kashiwazaki has shown that RMR may not be affected by the seasons when the body core temperature is preserved (26). On the other hand, body size, age, and gender have a significant effect on RMR. (27). Older adults we studied were unlikely affected by seasonal temperature changes, and therefore their RMR's remained unaltered during the year.

Seasonal changes are one of the most critical environmental factors that affect the frequency and duration of physical activity (4,6). In the spring or summer, older adults increase their house/garden activities, but they have reduced the level of physical activity in the wintertime. Previously, the level of physical activity of retired older persons was found more likely to be affected by the seasonal changes (7). In this study, 35.5% of the older adults exercised in the winter and spring and 48.4% exercised in summer and 41.9% exercised in autumn. Also, exercise preferences of all older adults were walking, probably because they found it more comfortable, safe and economical. Although performing regular exercise increased in summer and spring, the changes were not statistically significant. The ratio of older adults who had regular daily exercise was 27.3% in winter and 53.3% in summer (Table 1). Although these changes were not statistically significant, the numbers indicate the need for suitable places for older adults to do indoor exercise activities in cold periods of the year.

Step count was measured by motion sensors such as pedometers and accelerometers which are objective and reliable ways to assess the physical activity level even in older adults (28). In a Canadian study, the number of steps per day increased from 4901±2464 in winter to 5659±2611 in summer (15%) (29). In another study, physical activity status of women between 51 and 86 years of age was determined with pedometers, and the mean walking distance was 17.5±13.2 km in summer and 13.7±8.7 km in winter (30). In this study, the number of steps taken by the older people was not similar in all seasons and increased in summer and decreased in winter significantly. Our findings are in line with the result of other studies which reported that the frequency of physical activity decreased in cold and wet months and increased in hot and sunny periods such as summer and spring. METs values of older adults were lower than 3 in all seasons, indicating an overall mild intensity physical activity level throughout the year. When seasonal differences were evaluated, older adults' physical activity status were not adequate in all seasons even though the level of physical activity increased in summer. Moreover, seasonal changes on METs values were not statistically significant, probably because the participants limited their outdoor activities even under the best environmental conditions to prevent falls and related injuries at all seasons.

The present study allows compression of the duration of physical activity obtained by the armband and questionnaire. According to self-reports, the mean duration of exercise increased in summer (Table 2). However, according to armband readings, the duration of physical activity markedly declined in winter (Table 3). Overall, self-reported duration of physical activity was different from the armband data except for autumn. This finding supports the use of objective methods to assess the correct level of physical activity in older individuals.

In conclusion, it was found that seasonal variations affect to the frequency and duration of physical activity in a sample of older adults. However, RMR remained similar across four seasons in the same population. The results suggest that older adults need to be encouraged to increase the time of being physically active in cold and wet weather conditions like winter and autumn. Also, as a public health recommendation, it is essential to include some modifications in the environment of older adults during the winter, such as preference appropriate clothing or maintaining well-ventilated indoor activities to maintain physical activity.

Most important limitation of this study is absence of ambiance temperatures (home temperature etc.) measurement that older adults exposed to more than outside temperature.

Conflict of interest

The authors do not have any conflict of interest to disclose.

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