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Investigation of Relationships and Differences between Daily Step Count, Aerobic Endurance, and Leg Strength in Older Adults

Yaşlı Bireylerde Adım Sayısı ile Aerobik Dayanıklılık ve Bacak Kuvveti Arasındaki İlişki ve Farkların İncelenmesi

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ABSTRACT

Objective: The aim of this study was to investigate the relationship between leg strength, aerobic endurance and daily step count and the differences between the age groups among the retired and community-dwelling older adults.

Material and Methods: Thirty healthy older adults (aged ≥65, range 65-83 yrs) were included in the study. Step counts were measured with a pedometer for seven days. Leg strength was measured with the 30 s chair stand test, aerobic endurance was determined with the six-minute walk test.

Results: There were no significant relationships between daily step counts and leg strength (r=0.155, p=0.212) or aerobic endurance (r=0.129, p=0.252), (p>0.05), and neither between age and aerobic endurance (r=0.104, p=0.296), leg strength (r=-0.137, p=0.240), and daily step counts (r=-0.271, p=0.078). Between age groups, there were no significant differences in leg strength, aerobic endurance, daily step count, height and body weight, and body mass index (p>0.05). A significant relationship existed between daily step count and BMI (r=-0.340, p=0.036).

Conclusion: The older adults in this study had good leg strength, poor aerobic endurance. Daily step counts were not sufficient in older adults. Leg strength and aerobic endurance were not determining factors for low daily step counts. Checking themselves with a pedometer can help seniors improve their daily activity levels.

Keywords: Aging, physical endurance, muscle strength, body mass index, walking

ÖZ

Amaç: Bu araştırmanın amacı emekli ve toplum içinde yaşayan yaşlı bireylerin adım sayıları ile bacak kuvveti ve aerobik dayanıklılıkları arasındaki ilişki ve yaş sınıfları arasındaki farkları incelemektir.

Gereç ve Yöntemler: Araştırmaya 30 sağlıklı yaşlı birey katılmıştır (Yaş ≥65, aralık: 65-83). Günlük yürümedeki adım sayıları yedi gün boyunca ölçülmüştür. Adımsayar takılmadan önce bacak kuvveti 30 s otur-kalk testi ile, aerobik dayanıklılık 6 dk yürüme testi ile ölçülmüş ve yürüme mesafesi üzerinden değerlendirme yapılmıştır.

Bulgular: Adım sayısı ile bacak kuvveti (r=0.155, p=0.212) ve aerobik dayanıklılık (r=0.129, p=0.252) arasında anlamlı ilişki bulunmamıştır (p>0.05). Yaş ile aerobik dayanıklılık (r=0.104, p=0.296), bacak kuvveti (r=-0.137, p=0.240) ve adım sayısı (r=-0.271, p=0.078), arasında da anlamlı ilişki saptanmamıştır (p>0.05). Beden kütle indeksi (BKİ) ile adım sayısı arasında düşük düzeyde anlamlı ilişki bulunmuştur (r=-0.340, p=0.036). Yaş grupları arasında; bacak kuvveti, aerobik dayanıklılık, adım

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sayısı, enerji tüketimi, boy, beden ağırlığı ve beden kütle indeksi (BKİ) için anlamlı farklar çıkmamıştır (p>0.05).
Sonuç: Bu araştırmada yer alan yaşlı bireylerin bacak kuvvetinin iyi, aerobik dayanıklılığının zayıf ve günlük adım sayılarının uluslararası geçerli standartlara göre düşük olduğu bulunmuştur. Yaşlıların bir adımsayar yardımı ile günlük adım sayılarını kontrol etmeleri günlük aktivite düzeylerinin yükselmesine yardımcı olabilir.
Anahtar sözcükler: Yaşlanma, fiziksel dayanıklılık, kas kuvveti, beden kütle indeksi, yürüme

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INTRODUCTION

Sedentary lifestyle represents an important public health problem due to its negative effects on health (1). For this reason, older adults need to maintain a certain level of physical activity and physical fitness in every life stage, for their health. However, factors such as the living environment, home confinement, lack of exercise areas, problems in accessing existing areas for physical activity, and cultural and societal barriers cause older adults to become distanced from physical activity. In addition, retirement and decrease in professional activities during aging may affect the amount of daily walking routine.

Previous studies revealed that encouraging older adults to move and follow an active lifestyle through indoor activities, video-based exercise methods, walking around the house, helps maintaining daily activity and physical activity levels. If older adults monitor their step counts with devices such as pedometers, they may reach the daily targeted number of steps. Thus, they may meet daily physical activity criteria without being dependent on physical activity or exercise centers (2-4). The American College of Sport Medicine (ACSM) recommends walking as an endurance exercise for older adults (5). This exercise corresponds to a total of 7,000-10,000 steps, or at least 30 min of moderate physical activity per day (6).

However, there are not enough studies about the relationship between daily step count and functional performance in retired older adults. We do not know "our older adults' daily step counts", "whether these counts are enough" and "if there are relationships or differences among age groups" This study will provide some information about local older adults' step counts. Moreover, it will be first study that would report seven daily step counts. The aim of this study was to investigate the relationship between leg strength, aerobic endurance, and daily step counts of retired, community-dwelling older adults.

MATERIAL and METHODS

Research design and participants

The study was conducted by researchers of the Living Center for Older Adults, and Faculty of Sport Sciences at the Çanakkale Onsekiz Mart University between February 1 and March 30, 2019. The study included a total of 30 older adults (20 females and 10 males, aged ≥65, range 65-83 years). The participants were recruited from the Living Center for Older Adults via announcement. They were selected according to the following criteria: (i) to be ≥65 years of age, (ii) to be without serious cardiovascular, musculoskeletal diseases, and other serious diseases (osteoarthritis, osteoporosis, hypertension, diabetes, asthma, cancer) or chronic pain, iii) to be independent in daily living activities, without support or mobility aids, iv) to be independent in their walking routine, v) to be retired and not working, vii) to participate in only handiwork, painting, choir, chess or computer courses in the center. Participants who did not meet the inclusion criteria and who had participated in breathing exercises, posture training, muscle resistance, balance, flexibility, and fall-prevention exercises in the center for the last year were excluded from the study.

Cognitive function, depression, anxiety state and neurological assessments were not conducted in this study. Cognitive function had been evaluated previously prior to participation to activities in the center. All participants visited the center for physical and health state assessments before tests and for pedometer assessment. Medical assessments were conducted; resting heart rate, systolic blood pressure and diastolic blood pressure were measured during the first visit, before and after tests. Body mass index (BMI) was calculated (kg/m^2), and leg strength was evaluated using the chair stand test. Aerobic endurance was determined with the 6-min walk test in the following day. The tests were conducted by sport sciences researchers and the physical therapist.

The study was approved by the Ethics Committee of Social Sciences and Educational Sciences of the Çanakkale Onsekiz Mart University (Dec 27th, 2018; Protocol no: 2018/62). It was conducted in accordance with the Declaration of Helsinki. All participants were fully informed about the protocol, and signed written informed consent forms prior to the study.

Intervention

Pedometer: It was used to determinate daily step counts in the elderly (TNV brand, PM 2000 model). Participants were asked to carry it on the left side of their waist for a week and remove it only when performing personal care activities such as sleeping, showering or bathing. They were also asked to maintain their normal activity routine during the study. On the first day of the study they were instructed on how to attach the pedometer and how to remove it. Participants were also asked to return the pedometer at the end of the seven-day period. The daily and weekly step counts, the daily and total distances and the daily and weekly energy consumption were obtained from the apparatus.

The pedometer recording was repeated for some participants due to the following reasons: i) The pedometer was inactivated if not returned at the delivery time (four elderly), ii) Discontinued usage despite reminding via cell phone to wear it upon waking up (two participants), iii) Despite being reminded, forgetting to wear the pedometer for a full day (two subjects), iv) Dropping the pedometer, causing the apparatus to reset (three older adults), v) Lack of cooperation, discontinuing the study (two elderly), vi) Losing the pedometer (two participants), vii) Exhausted pedometer battery (one case), viii) Increased step count due to weekend trips (three subjects), ix) Inconsistent, highly variable daily step counts (four elderly). As a result; in this process, 53 measurements were conducted, but data were examined for the valid 30.

Chair stand test: Participants were asked to sit on the middle of a test chair - which had a sitting height of 43.2 cm, and no armrests - with their back straight, arms crossed on the chest, and their feet in full contact with the floor. They were then asked to fully stand up and to sit back down as many times as possible over a period of 30 seconds (7).

Six-minute walk test: Participants were asked to walk at a quick pace, but without running, for six minutes on a 45.7 m rectangular track with a smooth surface and cones placed on its corners. The test began upon the "start" command. When necessary, participants were allowed to rest on the chairs placed on the corners of the track, and to start walking again if the six-minute test period was not yet over. It was ensured that participants walked as fast as possible, but in a comfortable and safe manner, without compromising their health. At the end of 6 min, the individuals were stopped with the "stop" command (7).

Statistical analysis

All data were reported as means and standard deviations (SD). SPSS v26.0 was used for the analyses. The level of significance was set at 0.05. The Shapiro-Wilk test was applied to verify normal data distribution and Levene's test was used to assess equality of variances. Pearson's correlation coefficients were used to determine associations between step counts and BMI, 6-min walk test, and chair stand test results. The Kruskal-Wallis analysis was used for age group comparisons.

RESULTS

Thirty older, retired university graduate adults (20 females and 10 males), with no chronic diseases and/or smoking habits participated in the research. Table 1 provides the results for the participants, and Table 2 displays comparisons for age subgroups.

There were no significant relationships between daily step counts and aerobic endurance (r=0.129, p=0.252) or leg strength (r=0.155, p=0.212); nor between age and aerobic endurance (r=0.104, p=0.296), leg strength (r=-0.137, p=0.240), and daily step count (r=-0.271, p=0.078). A significant relationship between daily step counts and BMI was determined (r=-0.340, p=0.036).

There were no significant differences in height, body weight, BMI, daily step counts, aerobic endurance, leg strength, and energy consumption among age subgroups (Table 2)
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Table 1. Characteristics, step counts, and test data of older adults

Variables	Mean ± SD	Range
Age (yrs)	70.9 ± 3.8	65-83
Height (cm)	160.4 ± 7.3	150-183
Body weight (kg)	72.1 ± 9.3	55-90
Body mass index (kg/m²)	28.1 ± 3.5	21.0-34.1
Pedometer count (steps/day)	6011 ± 2089	1745-13083
Six minute walk test (m)	435 ± 94	280-802
Daily walking distance (m)	1879 ± 662	520-3924
Energy consumption (kcal)	185.1 ± 66.6	53-340
Chair stand test (n)	15.4 ± 4.2	01-25

Table 2. Anthropometry, step count, testing, and energy consumption comparisons in age subgroups

Parameter/Group	Age 65-70	Age 71-74	Age 75-83	χ^2; p
	(n=17)	(n=7)	(n=6)	
Height (cm)	160.1 (5.6)	164.7 (11.5)	156.7 (5.0)	2.271; 0.321
Body weight (kg)	72.9 (7.8)	70.0 (13.2)	71.7 (10.3)	0.486; 0.784
BMI (kg.cm-1)	28.5 (3.5)	25.7 (2.7)	29.1 (3.5)	3.658; 0.161
Step count (n/day)	6328 (1271)	6007 (3719)	5118 (2033)	0.326; 0.850
6-min walk test (m)	472 (190)	439 (45)	421 (53)	1.445; 0.486
Chair stand test (n/30 s)	17.5 (3.0)	15.4 (4.3)	13.2 (6.3)	3.142; 0.208
Energy consumption (kcal)	197.4 (54.0)	185.5 (98.5)	149.7 (61.5)	2.468; 0.291

Figures as means (SD, standard deviation); BMI: body mass index; χ^2: Kruskal-Wallis (degrees of freedom, df=2)

DISCUSSION

The purpose of this study was to examine the relationships between the daily step counts, leg strength and aerobic endurance, and to determine the differences between three age categories, in community-dwelling older adults. There were no significant relationships between daily step counts, leg strength and aerobic endurance for participants in the study. Daily step counts during the week are displayed in Fig 1. Although walking is the most common and easy form of physical activity in older adults, daily step counts varied between 4978 and 6786. This level was lower than recommended for older adults (6). Spartano et al. reported that the daily step count was 6927 in elderly with an average age of 68.6 years (8).

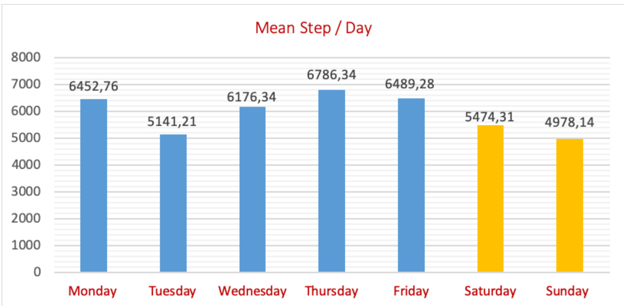

Figure 1. Daily mean step counts during the week

Other studies reported 4022 steps/day (3), and 3110 steps/day (9) in older adults. Despite these studies, Koizumi et al. (10) found that daily step count was 7811 in older women aged 60-78 years. Moreover, we determined that older adults in the present study have sedentary lifestyles according to the step count standard (11). The low levels observed were not a surprise. Differences among studies may have been resulted from usage of different devices, by differences in age groups and social factors, by differences in leg strength and in aerobic endurance, and also by different sample sizes. For this reason, it is difficult to compare step counts in older adults.

Another factor may be the seasonal climatic environment of the geographic area. Kimura et al. (12) reported that seasonality should be considered when analyzing physical activity and walking in older adults. We did not consider seasonal factors, and the study was conducted in the winter season. A further reason may be psychological factors such as depression, anxiety that were not considered in the study. These results suggest that many factors may have variable impacts on step counts of elderly. Finally, it was observed that older adults did not walk sufficiently in one week, and the pedometer was not used extensively among participants. We succeeded, however, to increase the number of pedometer users among older adults who participated in the study.

Aoyagi et al. (13) reported that fitness is well maintained in older adults who take >7000-8000 steps/day. Muscle strength is one of the fitness components. So, leg strength should be maintained in older adults for daily life activities such as walking, standing balance and standing up from the chair (4). Exercise is the best-known way to improve leg strength in older adults. However, as stated in the introduction, different responsibilities or cultural habits in societies can prevent older adults from attending exercise centers regularly or creating routine habits. We assumed that if high daily step counts were reached, it was possible to maintain leg strength without using an exercise center. But, according to the data in this study, there was no significant relationship between step counts and leg strength in older adults.

Chair stand performance was also evaluated in the study. In a study in healthy older adults (mean age of 74.4 yrs) living in Hong Kong, chair stand test repetition was determined as 10 reps/30 s. In another study, the figure of 15 reps/30s was observed (14). Investigating the effect of dance on physical function in healthy Greek older adults, the mean chair stand test figure was stated as 16 reps/30 s (15). In another study conducted in Spain, chair stand test results were determined to be 15.3 reps and 14.3 reps/30 s in healthy older men (mean age of 72.4 yrs) and older women (mean age of 72.2 yrs), respectively (16). Thus, comparing with similar studies, it seems possible to say that leg strength level of older adults is fair in the present study.

It was expected that good leg strength would increase the step counts of the participants. Despite that leg strength was good, step counts were not sufficient. Present findings are not consistent with other studies in this respect. Marques et al. (17) reported a significant correlation between lower extremity strength and walking ability. Likewise, similar studies have demonstrated a strong relationship between low muscle strength and decreased walking ability in older adults (18,19). Other studies have suggested that health benefits are apparent when taking approximately 8000-10000 steps/d (20,21). Even if leg strength is good, a decrease in daily walking routine, a decrease in work activities, the variety in daily activities, and the limitations in social life may affect step counts.

This finding again gives rise to the question: "Is good leg strength not enough to reach adequate step counts?" Leg strength may appear to be maintained without high step counts in older adults. Other factors may prevail. The individuals who participated in the study were retired and had not a job. It is also known that walking velocity and high step counts can contribute in transforming walking from a simple activity to an effort-intensive activity (22). However, walking velocity and social activities were not evaluated in the present study.

The other main question was that "Does aerobic endurance effect step counts in older adults?" In the present study, the 6-min walking distance mean was 435 m. We observed that our results were lower when compared with another study (3). Test distances were below normal according to the standards published by Rikli and Jones (7), and lower when compared to the results of another study (23). Some researchers found that the test distance was 600 m in older women (24). It was observed that aerobic endurance was lower than that obtained in some studies conducted on healthy older adults (24-28), and was higher compared with another (29). Accordingly, aerobic endurance was relatively low in our older adults, which may identify it as an important determinant of step counts.

There was a relatively weak relationship between daily step counts and BMI in older adults (Table 1). However, this moderate relationship is not a widespread finding, as some studies have determined no correlation at all (30-33). Findings are consistent with other studies: BMI and age are significant predictors of walking ability (17). Larger sample sizes are needed to indicate stronger correlation. Our results suggest that when the age factor is taken into consideration, it could be observed that aerobic endurance, muscle strength, and daily step counts decrease with aging. It is obvious that the older adults would need much more step counts.

This study had several limitations. Firstly, the sample group was relatively small. Experimental research with devices is often difficult to be conducted in elderly. They have quite varying individual differences such as physical, medical, social, psychological, and daily routine habits. However, the current study was fairly successfully conducted in older adults. Secondly, cognitive function, depression, anxiety state, and neurological assessments were not conducted. Depression and anxiety may affect outdoor walking routines. Thirdly, there were no studies to compare with in the same country. And lastly, physiological evaluations that may have effects on step counts, such as VO_{2max}, fatigue, and anaerobic threshold were not included in the study.

CONCLUSION

Leg strength in older adults was found to be good, aerobic endurance was low and daily step counts were not within the desired range. In the present study, participants' social environment interactions and types of daily activity were not questioned. We believe that in order to confirm our hypotheses, it will be necessary to also take social life and mobility aspects of older adults into consideration. Furthermore, it will be useful to examine other factors that may have effects on step counts in larger sample sizes.

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Conflict of interest

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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