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ORIGINAL ARTICLE

The effect of pedometer use on physical activity and body weight in obese women

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Abstract
Physical activity and healthy eating are of the utmost importance in treatment of obesity. However obese generally tend to have a sedentary lifestyle. Walking is a form of physical activity that is both simple and can be performed by everyone, but it requires an objective measurement. Number of steps taken during tracking can be recorded with the pedometer, a device used to measure the level of physical activity. We aimed to investigate whether or not using pedometers as a motivational technique to increase the level of physical activity in obese women has an impact on weight loss. Eighty-four obese women who are similar age referring to Ataturk University Faculty of Medicine Healthy Living Clinic, Turkey were randomly divided into two groups. Intervention group were given pedometers, and control group were prescribed similar diet and physical activity with a three-month follow-up plan without pedometers. Mean weight in pedometer group initially was 88.9 ± 8.4 kg, which decreased to 80.2 ± 8.7 kg after the programme. Mean weight in control group was 86.1 ± 9.2 kg at the beginning, and it decreased to 84.7 ± 8.8 kg after three months. It was observed in pedometer group that the mean number of steps 8817 ± 2725 steps/day at the beginning increased to mean 9716 ± 2811 steps/day at the end of the study. Weight, body mass index, body fat percentage and waist circumference measurements decreased more greatly in the pedometer when compared to the control group ($p < 0.001$). Pedometers may be recommended to obese patients to monitor and increase the level of physical activity and to promote weight loss.

Keywords: *Weight, obesity, management*

Introduction

Obesity, one of the most widespread diseases in the world according to World Health Organization (WHO) data, affects more than 300 million people (WHO, 2009). Obesity is known to be associated with several diseases, such as diabetes, hypertension, cardiovascular diseases, sleep apnea and osteoarthritis, and even several forms of cancer (Bray, 2004; Poirier et al., 2006). In addition to low-calorie diets, increasing physical activity and lifestyle changes are important in treating obesity. Physical activity in addition to low-calorie diets results in greater weight loss than diet alone and also protects muscle mass (Avenell et al., 2004; Dideriksen, Reitelseder, & Holm, 2013). It also ensures that weight loss is maintained for longer. Physical activity must therefore be included in programmes aimed at reducing body weight (Cannon & Kumar, 2009; McInnis, Franklin, & Rippe, 2003). However, obese individuals generally tend to sedentary lifestyle.

Diet lists established with specific calorie tables or exercise programmes may resolve weight problems in the short term. In the long term, however, it may be difficult to maintain weight due to a failure to implement lifestyle changes. Patient motivation must be continuously provided obesity management. Criteria that can measure patient efforts at physical activities are therefore needed. Walking is a form of physical activity that is both simple, and it can be performed by the vast majority of the population. However, this activity requires sensitive measurements to produce positive health benefits (Pomeroy et al., 2011; Simpson et al., 2003). Additionally, although pedometers are used to evaluate the number of steps that can be taken during walking in individuals of normal weight, studies testing the device in obesity subjects are limited (Swartz,

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Bassett, Moore, Thompson, & Strath, 2003). Pedometers ensure specific feedback on levels of physical activity, and they provide to increase activity of obese patients over time. Also using pedometer promotes self-efficacy by focusing on walking activities (Freak-Poli, Cumpston, Peeters, & Clemes, 2013). Although, pedometers are widely used in the measurement of physical activity in many countries, they are not yet common in Turkey (Church, Earnest, Skinner, & Blair, 2007; Sisson et al., 2010). The purpose of this study was to assess the effect of pedometer use as a motivational technique to increase the level of physical activity in obese women on weight loss. Weight change and body mass index (BMI) were used as the primary outcome measurements and changes in body fat percentage (BFP) and waist circumference (WC) as secondary outcome measurements.

Material and methods

Study design

This research was carried out between March and August 2013, at the Ataturk University Faculty of Medicine Healthy Living Clinic, Turkey. It was designed as a randomized controlled intervention study. Eligible obese women (n = 100) were allocated equally either to an intervention (pedometer) or a control group using computer-generated randomization lists (stratified randomization with random allocation sequences to ensure closely balanced groups). Both groups were given a low-calorie diet and exercise. All patients were monitored for three months. The pedometer group was also given Voit 3d® brand pedometers with a seven-day memory and digital data transfer capacity. The daily numbers of steps taken by the pedometer group were recorded through interviews at 15-day intervals. The control group subjects were seen twice, at the start of the study and after three months. The results from 84 patients were analyzed (Figure 1).

Patients

Twenty-seven patients in each group provided a statistical power of 95% for determining a difference of 1 kg weight loss in the two study groups with an alpha error of 5%, which was regarded as enough to compensate for losses during follow-up. Five hundred and twenty-two participants who referred our clinic were recruited and assessed in March/August 2013. Out of the 176 patients who did not met inclusion criteria, 246 patients declined to join the study. Remaining 100 patients were randomized into the pedometer and control group (Schulz, Altman, & Moher, 2010; Figure 1). Inclusion criteria were age equal or more than 18 years, willingness to participate in the study, BMI (weight (kg)/height (m^2) $\geq$ 30), no evidence of cardiovascular disease, diabetes and no history of medication for weight loss. The exclusion criteria were no desire to continue the treatment. All patients gave written consensus when they were included to the study. At the beginning of the study, women's weights, heights, BMI, BFP and WC were measured at baseline and after the three month. The change of weight and BMI were used as the primary, and changes BFP and WC as secondary outcome measures. Height and weight were measured by the researcher using a standard protocol at the start and at the end of treatment. The measurements were performed in the morning. Height was measured two times to the nearest 0.1 cm using a Harpenden Stadiometer and weight two times to nearest 0.1 kg using an electronic scale (Tanita®, Germany); the means of the measurements were recorded for analysis.

Ethics

Informed written consent was taken from all participants. Approval was sought from the ethics committee of Ataturk University of Medical Faculty before initiating the study (2013/12). This randomized controlled trial was performed according to the CONSORT statement and flow diagram.

Statistical analyses

All analysis was carried out using the SPSS 18 software. Numerical variables are expressed as mean ± standard deviation, and categorical variables as n (%). Numerical data were checked for normal distribution. Paired samples t-test and independent samples t-test were used in the comparisons, and the results given in 95% confidence interval. Chi-square test was used to compare categorical data. Pearson correlation analyze was used to evaluation the correlation between steps/day and weight. Also, repeated measures analysis of covariance (ANCOVA) were used to investigate the effect of the intervention on the outcomes using the baseline values as covariates. Significance level was set at $p < 0.05$.

Results

The mean age of the participant was 40 ± 10.2 years. Both pedometer group and non-pedometer control group had similar baseline characteristics regarding age, number of pregnancies, anthropometrical measurements ($p > 0.05$). Table I summarizes their baseline characteristics.

In analyses, women attending the pedometer group lost more weight (on average, 8.8 ± 2.9 kg)

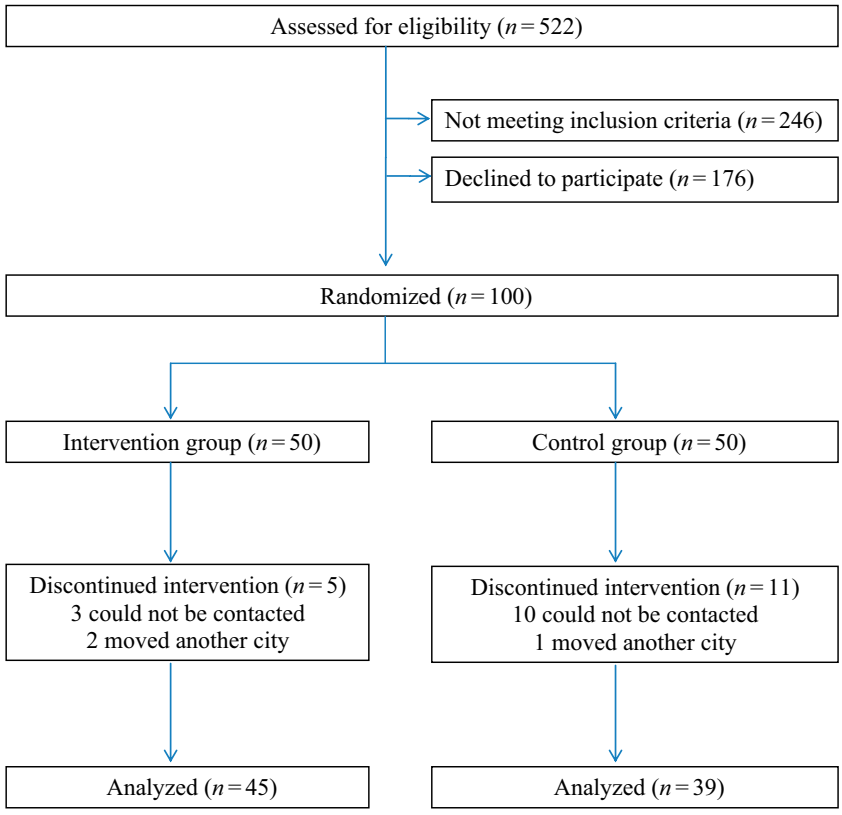

Figure 1. Flow of the patients.

than control group (on average, 0.4 ± 2.1 kg). After three months mean weight decreased from 88.9 ± 8.4 to 80.0 ± 8.7 kg (t = 14.8, $p < 0.001$) in pedometer group (Table II). Furthermore, using pedometer was more effective, when analyzed in two groups in terms of the difference in BMI, WC and BFP by using paired comparisons ($p < 0.05$; Table III). Also in an ANCOVA taking baseline weights, BMI, BFP as covariance the difference between pedometer and control group remained significant (F: 209; 197; 28 respectively, $p < 0.001$). During the study the mean number of total steps taken by the pedometer group was 9405 ± 2303 steps/day. Mean number of steps at the end of the three months (9716 ± 2811 steps/day) was significantly higher than that at the beginning (8817 ± 2725 steps/day; $p < 0.05$).

Mean number of total steps in the pedometer group and mean weight difference at the start of the study and the end of the three months were analyzed to determine any correlation. A positive but weak correlation was determined between step number and weight loss (p = 0.012, r = 0.373).

Table I. Baseline characteristics of participants

Characteristics	Pedometer group n = 45	Control group n = 39
Age (years)	41.1 ± 9.3	38.8 ± 11.2
Anthropometrics		
Height (cm)	157.7 ± 5.6	158.2 ± 5.2
Weight (kg)	88.9 ± 8.4	86.1 ± 9.2
BMI (kg/m^2)	35.9 ± 4.5	34.3 ± 2.8
WC (cm)	106.5 ± 7.3	104.4 ± 7.9
BFP (%)	42.7 ± 3.6	42.2 ± 4.2
Work status		
Housewife	37 (56.9%)	28 (66.7%)
Professional	8 (43.1%)	11 (33.3%)

BMI, body mass index; WC, waist circumference; BFP, body fat percentage.

Discussion

The results of our study suggest that using pedometer for three months is associated with improving weight, BMI, BFP and WC in obese women.

Lifestyle changes in diet and physical activity considered the cornerstone of weight loss programmes. Especially regular physical activity is associated with improvement of obesity and related risk (Kim, Tanabe, Yokoyama, Zempo, & Kuno, 2011; Strasser, 2013). A number of trials have demonstrated that the combination of physical activity and diet is more effective than either alone diet (Jakicic, Marcus, Lang, & Janney, 2008).

Recent guidelines suggest that 30 minutes/daily of physical activity of moderate intensity, performed every day should be encouraged. Public health initiatives promoting walking seem to be more

Table II. Comparison of mean anthropometrics measurements between two groups in beginning and third month

	Pedometer group n = 45 (mean ± SD)	Control group n = 39 (mean ± SD)	t	p
Weight (kg)				
Beginning	88.9 ± 8.4	86.1 ± 9.2	14.8	<0.001
Third month	80.0 ± 8.7*	85.6 ± 9.0		
BMI (kg/m^2)				
Beginning	35.7 ± 2.3	34.5 ± 2.8	14.3	<0.001
Third month	32.1 ± 2.7*	33.7 ± 2.7		
BFP (%)				
Beginning	42.7 ± 3.6	42.2 ± 4.2	5.4	<0.001
Third month	38.3 ± 3.9*	41.0 ± 4.3		
WC (cm)				
Beginning	106.5 ± 7.3	104.4 ± 7.9	4.7	<0.001
Third month	98.3 ± 7.7*	101.8 ± 7.9		

*$p < 0.05$.
BMI, body mass index; BFP, body fat percentage; WC, waist circumference; SD, standard deviation.

successful than others. Walking is available to everyone, and is the easiest form of physical activity since it is safe (Jakicic, Marcus, Gallagher, Napolitano, & Lang, 2003). One study in Switzerland showed that daily walking is more effective against obesity and adiposity than doing sport once a week (Danon-Hersch & Santos-Eggimann, 2013).

However, the need for objective measurement of physical activity has arisen in recent years, because patients' self-reports may not always be reliable. Objective measures of physical activity are not affected by reporting bias or recall problems associated with self-report methods. Pedometers are suitable for objective measurement of physical activity in clinical practice due to their small size and relatively low cost (Strasser, 2013; Trost & O'Neil, 2013). Pedometers also provide direct motivation by allowing obese patients to measure their physical efforts. Daily step count via pedometer provides a basis for giving feedback and setting walking goals (Cho, Oh, & Cho, 2013).

Opinions differ regarding how many paces a day are sufficient for adults. Although a figure of 10,000 steps/day has gained popularity in recent years, studies have shown that this target is not suitable for some adolescents and children (Tudor-locke & Bassett 2004). Physical activity of medium intensity for 30 minutes a day as recommended by guidelines in recent years equates to 3000–4000 steps with a pedometer (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008). In our study, no initial step target was imposed on the pedometer group. Nonetheless, the number of steps in the group rose steadily and approached 10,000. These results suggest that the pedometer is an effective means of increasing physical activity.

Pedometer step counts have been compared to obese patients in a number of previous reports. In a population-based cohort study, the authors shown that higher steps/day was related with lower BMI, lower waist to hip ratio (Dwyer et al., 2011). Also, in a cross-sectional study it was shown that steps/day were inversely associated with abdominal obesity (Jennersjö et al. 2012). Moreover, in our study we were able to find significant differences between pedometer and control group in terms of not only BMI but also BFP. These results suggest that pedometer usage is associated with significant decreases in BMI as well as BFP.

WC is an important parameter used in determining cardiovascular risk in obese individuals (Ashwell, Gunn, & Gibson, 2012; Bener et al., 2013; Wang & Hoy, 2004). Several previous pedometer-based interventional studies have shown a significant decrease in WC (Chan, Ryan, & Tudor-Locke, 2004; Freak-Poli, Wolfe, Walls, Backholer, & Peeters, 2011). At the end of our study we determined an approximately 2.6 cm decrease in WC in

Table III. Changes in anthropometrics between groups after three months

Outcome measures (means)	Pedometer group n = 45	Control group n = 39	p Value
Change in weight, kg (SD) [95% CI]	8.8 ± 2.9	0.4 ± 2.1	0.000*
Change in BMI, kg/m^2 (SD) [95% CI]	3.6 ± 1.2	0.1 ± 0.7	0.000*
Change in WC, cm (SD) [95% CI]	8.2 ± 5.3	2.6 ± 2.9	0.000*
Change in BFP,% (SD) [95% CI]	4.4 ± 3.1	1.2 ± 1.8	0.000*

Statistical significance: *Independent samples t-test.
BMI, body mass index; CI, confidence interval; SD, standard deviation.

the control group, but an 8.2 cm decrease in the pedometer group. These results suggest that the pedometer is a simple technique that can be recommended to protect obese patients against cardiovascular risk factors.

Strengths and limitations

Our attrition rate (16% at three months) and additional contact (15 days before and after) with the pedometer group were some limitations of this study. Sixteen patients dropped out because of time restrictions, changed residence and lost to follow-up due to change of contact information. One can also argue that there was potentially room to improve for the pedometer group, because they were 2.8 kg heavier at baseline. However, this difference was not statistically significant. On the other hand, study strengths included a randomized controlled design and the use of pedometer that can measure of physical activity objectively, and applied to obese women who more suffered from obesity in Turkey. To our knowledge, this study is the first randomized control trial to investigate the effectiveness of pedometer intervention in Turkey.

Conclusion

We conclude that the pedometer is a possible tool, which provides increasing of physical activity as a motivational technique. Also, this study demonstrated that using pedometers increases the number of steps taken per day and facilitates weight loss in obese patients.

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