Research Article

The Effects of The Pedometer-based Intervention on Body Composition in Middle-aged Thais with Overweight: A Preliminary Study

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Abstract

Background: Obesity and overweight are major risk factors of cardiovascular disease. Increased physical activity has been suggested to prevent cardiovascular diseases. However, most studies have been completed in North America and Europe; only a few studies were conducted in Asia. Therefore, the purpose of the study was to explore whether the effects of the pedometer-based intervention on body composition in participants who are overweight. Methods: Thirty-five overweight participants who had body mass index ≥ 25 $kg{\cdot}m^{-2}$ were participated and were assigned to the 12-week pedometer-based walking program (10,000 $steps{\cdot}d^{-1}$). Body composition was measured initially before and after the 12-week intervention. The amount of step-counts, 5-days a week was recorded in a diary booklet. Results: During the walking intervention, 30 individuals who had accumulated 10,000 $steps{\cdot}d^{-1}$ had a significantly lower body weight (-1.57 kg.), waist circumference (-2.48 cm), body mass index (.63 $kg{\cdot}m^{-2}$), and body fat percentage (-3.17 %), body fat mass (- 2.69 kg.), Lean body mass (1.12 kg.), Fat free mass index (1.08 $kg{\cdot}m^{-2}$), and body fat mass index (-1.08 $kg{\cdot}m^{-2}$) compared with measurement prior to the study program. Conclusions: The accumulation at least 10,000 $steps{\cdot}d^{-1}$ resulted in decreased body weight, body mass index, % body fat, and waist circumference. This has shown that an increase in physical activity by accumulating at least 10,000 $steps{\cdot}d^{-1}$ over 12 weeks can improve body composition in overweight Thai participants.

Keywords: physical activity; walking; pedometer; overweight; body composition

1. Introduction

Being overweight and obesity present major health problems in the world and these lead to non-communicable diseases (NCDs) and cardiovascular disease [1,2]. There are more than 1.4 billion overweight adults globally and this results in a major risk for chronic disease such as type 2 diabetes, cardiovascular disease, hypertension and stroke [3]. Further, the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III), the International Diabetes Federation (IDF), the World Health Organization (WHO), and the European Group for the Study of Insulin Resistance (EGIR) have been proposed as the clinical diagnosis criteria of metabolic syndrome (defined as ≥3 of the following: central

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obesity, elevated blood pressure, low high-density lipoprotein cholesterol, elevated triglycerides, impaired fasting glucose) and obesity (i.e., body composition (BMI), waist circumference) is one of the clinical component of metabolic syndrome [4]. In a survey in Thailand, a prevalence of being overweight and obesity (BMI ≥ 25 $kg \cdot m^{-2}$) among adults was up to 23.8 % [5]. Further, Aekplakorn et al. (2014) explored the prevalence of obesity (defined as BMI ≥ 25 $kg \cdot m^{-2}$) from Thai National Examination Survey in 2009. They found that 35% of Thai adults aged ≥ 20 years were characterized with obesity [6]. Interestingly, BMI in the Thai population increased with an average of 0.95 $kg \cdot m^{-2}$ per decade from 1991 to 2009. Furthermore, waist circumference (defined as central obesity) is associated with cardiovascular risk factors [7] and abdominal obesity (waist circumference and waist hip ratio) was shown to be independently associated with coronary heart disease in Thai men aged 35-59 over 17 years follow-up [8]. Regarding the relationship between obesity and physical activity, Banks, Lim, Seusman, Bain and Sleigh [9] investigated 74,981 adults aged 20-50 and found that 15.6% of Thai participants were obese (BMI ≥ 25 $kg \cdot m^{-2}$). Further, a negative association was associated with obesity and the total weekly sessions of exercise-related physical activity. In addition, total daily leisure-related computer use and television watching were correlated with the risk of being obese. Therefore, intervention to decrease a sedentary life style and increased physical activity should be considered.

Individual accumulations of 30 minutes of moderate intensity physical activity at least 5 days per week or 150 minutes per week has been recommended in all population groups to increase physical activity by the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) [10]. Walking (i.e., brisk walking) is generally recommended and equivalent to an alternative moderate physical activity. In addition, accumulating at least 10,000 $steps \cdot d^{-1}$ has been shown to meet the necessary minimum current physical activity required [11, 12]. Therefore, a daily step target of 10,000 steps has been generally suggested to improve health outcomes in sedentary lifestyle [13, 14]. In recent year, a pedometer or step-counting device has been commonly used to measure and promote physical activity. In addition, the benefit of a pedometer is easy to attach, less expensive, gives immediate feedback, and is a non-invasive method [15]. Several studies have been conducted on the effects of accumulating 10,000 steps per day on body composition or anthropometry in overweight participants. However, little is known regarding the effects of walking with a pedometer on the body composition of overweight adults in a community setting. Therefore, the aim of this study was to determine the effects of accumulating 10,000 steps per day with a pedometer on body composition that might be a risk of cardiovascular disease in overweight participants in a community setting.

2. Materials and Methods

2.1 Participants and Design

Thirty-five participants were recruited from the community aged 35-59 with overweight adults (defined as BMI ≥ 25 $kg \cdot m^{-2}$). Written and informed consent were obtained. In addition, the ethics and protocol were approved by the Ethics committee of Thammasat University. The quasi experimental was designed to determine whether the effect of a pedometer decreased the body composition.

2.2 Measures and Apparatus

Two experimenters were trained in the measurement protocol by the same trainer. Measurements of weight, height, body fat percentage; waist circumference and hip circumference were obtained prior and after the intervention program. Evaluation of body composition was performed by a bioelectric impedance (BIA) device which is an Omron HBF-375 Body composition monitor (Omron Healthcare Co., Ltd., Japan). Body weight (kg), lean body mass (kg), body fat mass (kg), and the percentage of body fat were assessed. Body mass index (BMI; kg·m^{-2}) was used as an indicator of being overweight. The BMI is calculated as body weight (kg) divided by height squared (m^2). It is known that body mass is composed of two distinct components; fat-free mass and body fat mass. Therefore, fat-free mass index (FFMI; kg*m^{-2}) and body fat mass index (BFMI; kg·m^{-2}) were calculated. These indices are divided as fat-free mass (kg) and body fat mass (BFM; kg) by height squared (m^2) respectively. Height was measured to the nearest 0.1 centimeters with a wall-mounted stadiometer (Seca Corporation, Columbia, MD). In addition, changing in walking steps a day was calculated by subtracting initial baseline walking steps per day from walking steps per day at a 12-week. According to the National Heart, Lung and Blood Institute (NIH) Practical guide to obesity, the waist circumference should be measured at the level of the umbilicus or navel. In addition, hip circumference was measured at the level of the greatest gluteal protuberance [16]. Standing waist and hip circumferences were measured using a tape measure in centimeters. To reduce measurement error, height, waist and hip were measured twice and the average values were calculated. Waist to hip ratio was then computed from these measures.

Baseline walking steps per day were measured with the Yamax Digi-Walker SW-200 (Yamax Tokei Keiki Co., Ltd., Tokyo, Japan). Individuals were asked to wear their sealed pedometer during the working day for 5 days whilst following their normal daily routine and then record the details in their booklet. At the 12-week intervention, the participants were instructed to walk at least 10,000 steps per day and record their steps in their diary.

2.3 Statistical Analysis

Steps per day were calculated weekly (i.e., only 5 working days per week was averaged). The change in the average number of steps per day over the 12-week intervention program was modeled for each participant. Descriptive data was presented as a percentage (%), mean and standard deviation (SD). Data was verified for normality of distribution (Komogorov Siminov Goodness of Fitness test). Paired t-test was performed to determine the effects of the pedometer-based intervention on body composition. To evaluate the utility of the pedometer for improving health outcomes in overweight participants, a regression analysis was performed. Multiple regression analyses were conducted to determine the unique contribution of 10,000 steps per day to the improvement of waist circumference after adjustment for gender, age, initial steps, initial value and change in steps.

3. Results

Nine males and 21 females participated in this study. The mean age of the participants was 49.67 ± 6.51 years. Average steps a day during week 1 and week 12 in each participant were presented in Figure 1. The figure illustrates significant increases in walking steps a day from initial baseline to at a 12-week intervention (p < .001). As shown in Table 1, significant -Δ body weight, -Δ BMI, -Δ WC, -Δ %BF, -Δ BFM, and -Δ FFMI were evidenced after the pedometer based intervention program. LBM and FFMI likewise increased significantly (p < .01 in all cases).

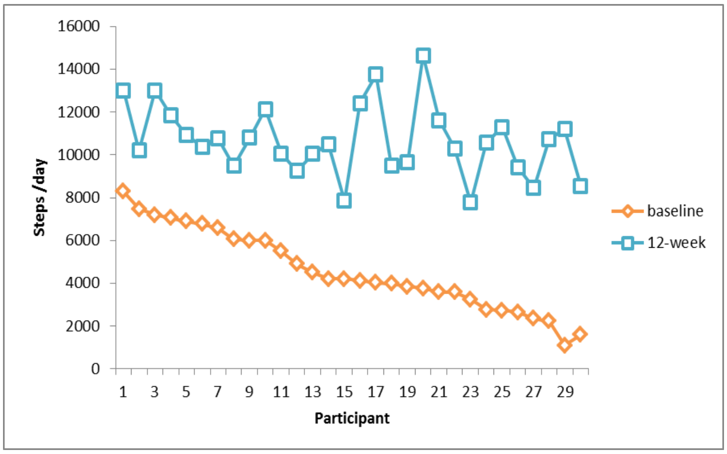

Fig.1. Walking steps a day before and after intervention program in each participant.

Table1. Compared pre and post pedometer intervention program in overweight participants.

	Pre	post 12-wk	*t* (29)	*p*-value
Walking (steps/day)	4,540.53 ±1,959.00	10,500.20 ± 2070,543	-14.97	< .001
WC (cm)	92.63 ±9.26	90.33 ± 8.16	3.13	.004
WHR	.89 ± .06	.88 ± .05	.72	.477
Body weight (kg)	71.40 ± 10.73	69.87 ± 10.33	3.15	.004
BMI (kg/m^2)	27.86 ± 4.33	27.25 ± 3.93	2.88	.007
BF (%)	32.97 ± 6.89	29.82 ±7.29	6.70	<.001
BFM (kg)	23.98 ± 7.47	21.33 ± 7.43	6.788	<.001
LBM (kg)	47.42 ± 5.57	48.54 ± 5.21	-2.94	.006
FFMI (kg/m^2)	18.46 ± 1.75	18.91 ± 1.61	-2.83	.008
BFMI (kg/m^2)	9.41 ± 3.12	8.34 ± 2.95	6.37	<.001

WC, waist circumference; WHR, waist hip ratio; BFM, body fat mass; LBM, lean body mass; BMI, body mass index; BFMI, body fat mass index; FFMI, fat-free mass index

Table 2. Multiple regression analysis effect of 10,000 steps per day on waist circumference from baseline characteristics and an increase in steps per day.

Regression model	*B*	*β*	*T*	*R2*	*F*
Age	-.032	-0.26	-.299		
Gender	-1.490	-.085	-.966		
Initial waist circumference	.876	.994	10.402 ***		
Initial walking steps/day	.000	-.035	-.379		
Change in walking steps/day	-.001	-.209	-2.121*	.846	26.374***

$^{*}p < .05$, $^{***}p < .001$

In addition, the study examined whether the contribution of walking steps·d^{-1} to the prediction of follow-up body composition. As can be seen in Table 2, future waist circumference was related to both an initial waist circumference and the changes in walking steps per day (p < .05). The waist circumference increased with decreased walking steps per day (≥ 10,000 steps per day).

4. Discussion

The present study evaluated the efficacy of accumulating 10,000 steps per day on the body composition with overweight participants in a community setting. Further, these participants were leading a sedentary lifestyle (defined as accumulating less than 5,000 steps per day [12, 17]. The main findings of the present study were that participants displayed decreased body weight, BMI, waist circumference, percentage of body fat, body fat mass, fat free mass, fat free mass index (1.53 kg, 0.61 kg·m^{-2}, 2.3 cm, 3.16%, 2.64 kg, and 0.45 kg·m^{-2}, respectively). Otherwise, lean body mass and lean body mass index increased by 1.12 kg, and 1.07 kg·m^{-2} respectively, following the 12-week walking intervention.

The results confirm recent findings indicating that walking 10,000 steps per day is effective in increasing physical activity. In particular, a meta-analysis of 26 studies from 1966 to 2007 suggested that using a pedometer increased physical activity [18]. Further, the beneficial change in loss of weight was demonstrated in the current study which concurred with other studies; decreased body weight, BMI, percentage body fat and waist circumference. Yamanouchi et al. (1995) evaluated the effects of walking at least 10,000 steps per day combined with diet in obese non-insulin dependent diabetes mellitus patients compared with diet alone. Body weight in both groups decreased significantly after an 8-week follow-up. However, the amount of body weight reduction in the group walking combined with diet therapy was greater than that in the group of diet alone [19]. Chan et al. (2004) demonstrated that 12 weeks of 10,000 steps per day resulted in a significantly lower BMI and waist girth in 106 sedentary workers [20]. Schneider et al. (2006) examined the effect of 10,000 steps per day on 38 adults with a sedentary lifestyle and who were overweight/ obese for 36 weeks. They reported that 10,000 steps per day resulted in weight loss and that these participants had shown a significant decrease in body weight, BMI, percentage of body fat, fat mass, waist circumference and hip circumference over 36-weeks in overweight participants [13]. Further, systematic review with meta-analysis [18] reported that increases in steps per day were associated with a decreased BMI by 0.38 kg·m^{-2} from baseline, with a range from -0.05 to -0.72 kg·m^{-2} which was similar to the amount of changes in BMI (-0.61 kg·m^{-2}) in the present study. Again, a meta-analysis of randomized controlled trials reported that body weight, BMI, percentage of body fat in sedentary adults have been decreased after a walking intervention program [21]. Recently, Tudor-Locke (2010) described pedometer-based guidelines and cardiovascular health outcomes. He concluded that increasing walking can alter changes in BMI and are related to cardiovascular health outcomes [22]. Thus, accumulating at least 10,000 steps per day may, in part, account for a reduction in waist circumference, and BMI during the walking program.

However, there is some evidence that the effects of accumulating at least 10,000 steps per day on body composition (e.g., waist circumference, BMI) did not observe changes in anthropometric measures or body composition [1, 13, 23]. Clemes et al. (2007) assessed healthy participants with either normal weight or being overweight with a 10,000 daily step count over 4-weeks. They revealed that body weight, BMI and the percentage of body fat were not observed in the differences between groups at 4 weeks or baseline versus 4 weeks[1]. Similarly, Araiza et al. (2006) reported that BMI and body fat showed no differences or changes either between 10,000 steps per day and the control groups both before and after study during the 6 weeks [23]. Likewise, Swartz et al. (2003) had shown that 18 overweight participants with a family history of type 2 diabetes mellitus showed no changes in BMI, body fat percentage and wrist circumference during an 8-week walking program [24]. Therefore, the duration of the walking intervention may be problematic. A longer intervention would be more appropriate to determine accurate results and might provide more information on the effects of using the pedometer to increase physical activity on body composition. In the present study, a 12-week intervention was examined and the results confirmed the effects of body composition and walking 10,000 steps per day.

The study also evaluated whether changes in accumulating 10,000 daily steps predicted body composition over 12 weeks. A multiple regression analysis for follow-up body composition was performed. The present study found that decreasing walking steps per day was related to an increase in waist circumference. However, decreases in future BMI were not associated with increased walking steps daily ($p > .05$). Yet, the systematic review found that the reduction in BMI was not significantly associated with the baseline steps per day and change in walking steps per day [18]. Waist circumference has been suggested as being reflective of abdominal adiposity in predicting cardiovascular risk [3]. Further, increased visceral adipose tissue has been associated with increased waist circumference [25]. In addition, BMI and waist circumference are one of the components of the definition of metabolic syndrome [4] (e.g., WHO, 1998; NCEP ATP III, 2005; EGIR, 1999; and IDF, 2005). Therefore, the results of the present study suggest that the effects of a pedometer may be attributed, at least in part, to a decrease in metabolic syndrome by which a reduced waist circumference or BMI then resulted in a reduction and risk of cardiovascular disease.

There are a number of limitations with the present study. The control group was not examined; a randomized control trial might be needed. Participants might have changed behavior (e.g., changing diet) during the walking program and that may have resulted in a decrease in body composition. The study had a relatively small sample size and most of the participants that were recruited in females (70%). Therefore, results may not be used to draw conclusions for the whole population. Because the purpose of this study was to determine the effect of an average of 10,000 steps per day on the body composition in overweight adults, a larger sample size with random control trials are needed.

5. Conclusion

Intervention with a pedometer can increased physical activity and the effect of walking with the goal of accumulating 10,000 steps per day results in an improvement of body composition (i.e., decreased body weight, BMI, body fat percentage, waist circumference) in overweight participants.

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7. References

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