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Review

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Using Pedometers to Increase Physical Activity and Improve Health

A Systematic Review

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ABSTRACT

Context Without detailed evidence of their effectiveness, pedometers have recently become popular as a tool for motivating physical activity.

Objective To evaluate the association of pedometer use with physical activity and health outcomes among outpatient adults.

Data Sources English-language articles from MEDLINE, EMBASE, Sport Discus, PsychINFO, Cochrane Library, Thompson Scientific (formerly known as Thompson ISI), and ERIC (1966-2007); bibliographies of retrieved articles; and conference proceedings.

Study Selection Studies were eligible for inclusion if they reported an assessment of pedometer use among adult outpatients, reported a change in steps per day, and included more than 5 participants.

Data Extraction and Data Synthesis Two investigators independently abstracted data about the intervention; participants; number of steps per day; and presence or absence of obesity, diabetes, hypertension, or hyperlipidemia. Data were pooled using random-effects calculations, and meta-regression was performed.

Results Our searches identified 2246 citations; 26 studies with a total of 2767 participants met inclusion criteria (8 randomized controlled trials [RCTs] and 18 observational studies). The participants' mean (SD) age was 49 (9) years and 85% were women. The mean intervention duration was 18 weeks. In the RCTs, pedometer users significantly increased their physical activity by 2491 steps per day more than control participants (95% confidence interval [CI], 1098-3885 steps per day, $P < .001$). Among the observational studies, pedometer users significantly increased their physical activity by 2183 steps per day over baseline (95% CI, 1571-2796 steps per day, $P < .0001$). Overall, pedometer users increased their physical activity by 26.9% over baseline. An important predictor of increased physical activity was having a step goal such as 10 000 steps per day ($P = .001$). When data from all studies were combined, pedometer users significantly decreased their body mass index by 0.38 (95% CI, 0.05-0.72; *P* = .03). This decrease was associated with older age (*P* = .001) and having a step goal (*P* = .04). Intervention participants significantly decreased their systolic blood pressure by 3.8 mm Hg (95% CI, 1.7-5.9 mm Hg, *P* < .001). This decrease was associated with greater baseline systolic blood pressure (*P* = .009) and change in steps per day (*P* = .08).

Conclusions The results suggest that the use of a pedometer is associated with significant increases in physical activity and significant decreases in body mass index and blood pressure. Whether these changes are durable over the long term is undetermined.

INTRODUCTION

Increased physical activity is associated with improvements in numerous health conditions, including coronary artery disease, hypertension, stroke, insulin sensitivity, osteoporosis, and depression.[1-4] Because of these extensive health benefits, the Department of Health and Human Services recommends "physical activity most days of the week for at least 30 minutes for adults."[5] Despite these recommendations and the well-documented evidence that physical activity is beneficial, more than half of all adults in the United States do not get adequate physical activity and approximately one quarter do not get any leisure time physical activity.[6]

The costs associated with physical inactivity are high. For example, if 10% of adults in the United States began a regular walking program, an estimated $5.6 billion in heart disease costs could be saved.[6] Pedometers are small, relatively inexpensive devices worn at the hip to count the number of steps walked per day. Although there is not detailed evidence of their effectiveness, they have recently experienced a surge in popularity as a tool for motivating and monitoring physical activity.[7] Additionally, some guidelines specifically recommend taking 10 000 steps per day.[8] However, it is not known whether encouraging adults to walk 10 000 steps per day is associated with any significant improvement in health outcomes compared with not setting a goal or to setting an alternative activity goal.

The primary purpose of this study was to evaluate the association between pedometer use and physical activity among adults in the outpatient setting. Additionally, we sought to determine the association between pedometer use and changes in body weight, serum lipid levels, fasting serum glucose and insulin, and blood pressure. Finally, we sought to evaluate the association between setting a daily step goal and improvements in health outcomes.

METHODS

Data Sources and Search Strategies

In collaboration with a professional librarian, we developed individualized search strategies for 7 databases: MEDLINE (January 1966 to February 2007); and EMBASE, Sport Discus, PsychINFO, Cochrane Library, Thompson Scientific (formerly known as Thompson ISI), and ERIC (January 1966 to May 2006). We used search terms such as *pedometer*, *activity monitor*, and *step counter*. We also reviewed the bibliographies of retrieved articles and relevant conference proceedings and contacted experts in exercise physiology for additional studies.

Study Selection

We considered English-language studies eligible for inclusion if they reported an assessment of pedometer use among adult outpatients, included more than 5 participants, and reported a change in number of steps walked per day. We excluded studies that required participants to be hospitalized or confined to a research center, sealed the pedometer so that intervention participants could not see the number of steps walked per day (often the control subjects wore sealed pedometers), or used a pedometer to measure the effects of a drug on an individual's ability to be physically active.

Data Extraction

Two authors independently abstracted 4 categories of variables from each of the included studies: intervention variables (eg, intervention duration, whether counseling was included, and whether participants were asked to achieve a particular activity goal); participant variables (demographics; baseline activity; and the presence or absence of obesity, diabetes, hyperlipidemia, or hypertension); outcome variables (number of steps per day, measures of body mass, glycemic control, serum lipid levels and blood pressure); and quality variables (method of blinding control participants to step counts, the extent to which participants participated fully in the activity program, methods used to determine baseline physical activity, completeness of follow-up and use of intention to treat analysis, the use of validity- and reliability-tested pedometers, and the extent to which cointerventions may have affected physical activity). If a study reported both immediate postintervention and longer-term follow-up data, we used the immediate postintervention data in our primary analyses.

We resolved discrepancies by repeated review and discussion between abstractors. If 2 or more studies presented the same data from a single patient population, we included these data only once in our analyses. If a study presented data on 2 types of activity programs and if 1 of the programs did not meet our inclusion criteria (eg, 1 program without a pedometer), then we abstracted data for only those participants receiving the intervention that met our inclusion criteria.

Data Synthesis

For each of the included studies, we calculated 2 effect sizes for each of the outcomes of interest: the mean difference (postintervention steps per day − preintervention steps per day) and standardized mean differences ([postintervention steps per day − preintervention steps per day]/pooled standard deviation). The standardized mean difference lacks units, which limits its interpretability, whereas the mean difference retains its units, which facilitates clinical interpretation. For randomized controlled trials (RCTs), we also calculated the difference in the preintervention and the postintervention changes in outcomes between the intervention and control participants. Because we found no significant differences in summary results between these 2 outcome metrics, we present only the mean differences. We calculated summary outcomes using both random-effects and fixed-effects calculations and found no significant differences between the 2, thus present only the random effects estimates.

Because the participant, physical activity, and outcome variables evaluated are correlated, the corresponding effect sizes for these measures are correlated.[9] We used meta-regression weighted by the sample size to calculate the summary effect of the physical activity and participant characteristic variables on the outcome variables.[10]

We performed sensitivity analyses and assessed heterogeneity to evaluate the robustness of our results. We removed each study individually to evaluate that study's effect on the summary estimates. We assessed publication bias by visual inspection of funnel plots comparing physical activity (x-axis) to sample size (y-axis) and calculated the fail-safe N (the number of missing studies that would be required to change a significant summary effect to one that was not statistically significant).[11] For each summary effect size, we assessed statistical heterogeneity by calculating the *Q* statistic (considered *Q* statistics with $P < .05$ as heterogeneous) and I^2 statistic (considered I^2 statistics greater than 50% as heterogeneous).[9, 12] We considered and evaluated heterogeneity through predetermined subgroup analyses (eg, demographics, body mass index, which is calculated as weight in kilograms divided by height in meters squared), baseline activity, intervention type, intervention setting, study design, etc. We performed analyses using Comprehensive Meta-Analysis v.2 software (Biostat, Englewood, New Jersey).

RESULTS

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Our searches identified 2246 potentially relevant articles (Figure 1). We e-mailed the authors of 13 of the studies that met inclusion criteria but reported insufficient data to be included in our analyses—3 provided sufficient data to be included in our study.[13-15] After synthesizing the data from multiple reports on the same set of participants, 26 studies met our inclusion criteria (Table 1).[13-39]

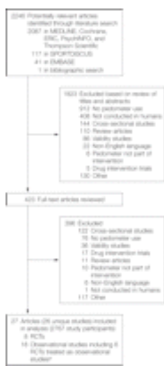

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Figure 1. Study Flow Diagram

CI indicates confidence interval; RCT, randomized controlled trial.[a] Six RCTs that used visible step counts in both trial cohorts were each treated as separate observational studies.

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Table 1. Study Characteristics: Randomized Controlled Trials and Observational Studies

Study Characteristics

The designs of the included studies were highly heterogeneous. Eight of the included studies were RCTs in which the intervention participants wore pedometers and were encouraged to view and record their daily step counts, whereas the control participants wore pedometers that were sealed so that they could not see their own step counts.[14, 16-23] Six additional RCTs used pedometers with visible step counts in both trial cohorts, so we treated each of these cohorts as separate observational studies.[25, 30-32,35, 37] Twelve studies were single-group observational studies.[13, 15, 24, 26-29,33, 36, 38-39]

Overall, the quality of the reporting of the included studies was relatively good. Only 4 studies did not specify the method by which participants' baseline physical activity was determined (most asked participants not to change their usual activity and to wear a sealed pedometer for 3 to 7 days prior to the start of the intervention to determine baseline activity). Nine studies had 100% of participants complete the intervention, and the average dropout rate among the other studies was 20%—a rate that is somewhat higher than the 4% to16% dropout rate reported by other physical activity interventions.[40] Sixteen studies used the Yamax pedometer (Yamax Corp, Tokyo, Japan)—a model that has been well validated for accuracy and reliability and is frequently used in physical activity research.[41-44]

The physical activity interventions evaluated in the included studies varied considerably: mean (SD) duration was 18 (24) weeks (range, 3-104 weeks), 5 took place in the workplace, 23 included a step diary, and 17 included physical activity counseling with a mean (SD) number of 7 (19) counseling sessions (range, 0-104 sessions). Only 3 studies included dietary counseling: 1 study prescribed a diet,[15] and the other 2 gave advice on a healthful eating habits.[26, 36] Twenty studies were from the United States or Canada, 2 were from Japan, 2 were from Europe, and 2 were from Australia.

Participant Characteristics

The included studies evaluated 2767 participants of physical activity programs (Table 2). Their mean (SD) age was 49 (9) years, and only 5 studies had participants whose mean age was more than 60 years. Nine studies exclusively enrolled women and overall, only 15% of the participants were men. Seven studies reported participants' race/ethnicity—the mean (SD) proportion of white participants was 93% (7.5%). Most participants were overweight, normotensive, and had relatively well controlled serum lipid levels. Most participants were relatively inactive at baseline with a mean (SD) of 7473 (1385) steps per day (range, 2140-12 371 steps per day).

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Table 2. Baseline Participant Characteristics[a]

Pedometer Use and Physical Activity

RCT Results. Figure 2 shows the difference between the increase in physical activity among the participants randomly assigned to pedometer use and control participants in the 8 RCTs. Figure 2 shows that the 155 intervention participants significantly increased their physical activity by 2491 steps per day more than the 122 control participants (95% confidence interval [CI], 1098-3885 steps per day, $P < .001$). However, this result was statistically heterogeneous ($Q = 74.9$, $P < .001$; $I^2 = 91$). When we removed the study by Moreau et al,[20] a 24-week exercise intervention involving postmenopausal hypertensive women, which reported a much higher increase in physical activity than any of the other trials, the summary increase in physical activity among the remaining intervention participants was 2004 steps per day more than the control participants (95% CI, 878-3129 steps per day, $P < .001$).

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Figure 2. Increase in Physical Activity Among Participants Randomly Assigned to Pedometer Interventions vs Control Participants

Presents the difference in the change in steps per day before and after the intervention between the participants in the experimental and control arms of the randomized controlled trials. The size of the data markers are proportional to the sample size, which represents the number of individuals who completed the trials.

Observational Study Results. Among the observational studies, the pedometer users significantly increased their physical activity by 2183 steps per day over baseline (95% CI, 1571-2796 steps per day, $P < .001$).

Overall, pedometer users increased their physical activity by 26.9% over baseline. We did not find evidence of significant publication bias (eg, fail-safe N was 127). However, this result was statistically heterogeneous ($Q = 212$, $P < .001$; $I^2 = 89$), which is not surprising given the differences in the physical activity interventions.

Predictors of Improvements in Physical Activity. We used meta-regression to evaluate the participant and intervention characteristics associated with increased physical activity among pedometer users in RCTs and observational studies. Among the participant characteristics, there was a trend for studies of younger pedometer users and those with less baseline activity to have the greatest increases in physical activity, albeit not statistically significantly ($P = .06$ and $P = .09$ respectively). Sex, BMI, and race/ethnicity were not significant predictors of increased activity.

Among the intervention characteristics, having a step goal was the key predictor of increased physical activity ($P = .001$). Indeed, the 3 studies that did not include a step goal[14, 21-22,36] had no significant improvement in physical activity with pedometer use in contrast to increases of more than 2000 steps per day with the use of the 10 000-step-per-day goal or other goal (Table 3). Only 2 studies reported the number of participants who achieved their step goal, limiting our ability to stratify our analysis by this factor.

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Table 3. Use of a Step Goal

Notably, participants in the studies that did not require the use of a step diary[17, 34, 42] did not significantly increase their activity over baseline (mean change, 832; 95% CI: −258 to 1922 steps per day; $P = .10$), whereas participants in interventions that required the use of a diary did (mean change, 2649; 95% CI, 2032 to 3266 steps per day, $P < .001$). Five studies measured participants' adherence with keeping a step diary (mean [SD] 83% (20%) adherent).

Having the intervention in a setting other than the workplace also predicted increased physical activity

(P = .02). This may be explained by the finding that the workplace interventions tended to include participants with relatively high baseline physical activity (Figure 3). Intervention duration and physical activity counseling were not significant predictors of increased steps per day. There was no statistically significant difference in effect sizes between the interventions that used a Yamax brand pedometer vs another pedometer.

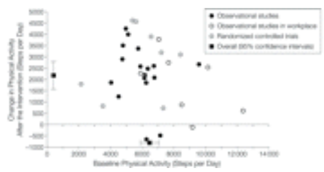

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Figure 3. Association of Baseline Physical Activity With Change in Physical Activity After the Intervention

Presents the association of baseline physical activity in steps per day (x-axis) with the change in physical activity in steps per day (y-axis). The Figure includes both the RCTs and the observational studies. The data markers representing the workplace interventions include all the study groups in each trial: Butler and Dwyer[17] and Croteau et al[28] each had 3 study groups; Eastep et al,[25] Thomas et al,[34] and Wyatt et al[39] each had 2 study groups. The mean change in steps per day was 1964 over baseline (P = .01).

Pedometer Use and Health Outcomes

We used regression, weighted by the sample size, to evaluate the association between steps per day and improvements in health outcomes. For these analyses, we included the change in activity and outcomes from baseline among all participants using pedometers (from both the RCTs and observational studies).

Change in BMI. Intervention participants significantly decreased their BMI by 0.38 from baseline (P = .03, Table 2). This was a statistically homogeneous result. This decrease was associated with older age (P = .001), increasing percentage of white participants (P = .009), having a step goal (P = .04), and interventions of longer duration (P = .07 for trend). The decrease in BMI was not significantly associated with baseline steps per day, change in steps per day, sex, diet counseling, or BMI at the start of the intervention.

Change in Blood Pressure. Intervention participants significantly decreased their systolic blood pressure by 3.8 mm Hg ($P < .001$) and their diastolic blood pressure by 0.3 mm Hg (P = .001) (Table 2). These were statistically heterogeneous results. This decrease was associated with greater systolic blood pressure at baseline (P = .009) and change in steps per day (P=.08 for trend) but not significantly associated with age, change in BMI, setting a step goal, or intervention duration.

Other Health Outcomes. Six studies reported change in low-density lipoprotein levels, and 7 studies reported change in serum glucose concentration. Intervention participants did not significantly improve their serum lipid levels or decrease their fasting serum glucose concentration (Table 2)—not a surprising finding given that these values were fairly normal for participants at baseline.

COMMENT

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The results of this meta-analysis, which is to our knowledge, the first published quantitative synthesis of the literature on the effectiveness of pedometers, suggest that pedometer use is associated with significant increases in physical

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activity—a magnitude of about 2000 steps or about 1 mile of walking per day. Moreover, the use of pedometers may be associated with clinically relevant reductions in weight and blood pressure.

We found that setting a step goal and the use of a step diary may be key motivational factors for increasing physical activity. Pedometer users who were given a goal, whether the 10 000-step goal or an alternative personalized step goal, significantly increased their physical activity over baseline, whereas pedometer users who were not given a goal did not increase their physical activity. The study by Sidman et al[30] specifically compared alternative goals in an RCT. In their intervention involving sedentary women aged 20 to 65 years, they found that although participants with low levels of baseline activity rarely reached their goal of 10 000 steps per day, they increased their steps as much as those asked to achieve a more modest goal.[30] Given the relatively similar increases in physical activity among those pedometer users given the 10 000-step goal and users given other goals, we conclude that the relative benefits of setting different goals remains unclear.

We found that workplace interventions were associated with relatively small increases in physical activity. Workplace exercise programs have been criticized for attracting staff who are already active[34]—our results corroborate this observation. Thus, for workplace interventions to have a broader health benefit, they might need to specifically target sedentary employees who are not currently engaged in a walking or other exercise program.

We did not find that physical activity counseling increased steps walked per day. This may have been because of the heterogeneity of the counseling provided by the included studies (with some providing several weekly sessions to motivate walking and give individualized feedback, whereas others provided only a brief general physical activity lecture). Additionally, some studies that provided some counseling may not have specifically reported doing so. Our results are in keeping with a recent systematic review that found mixed results of the effects of physical activity counseling for adults in the primary care setting.[45]

Pedometer users had significant reductions in BMI; however, their weight loss was not a function of increase in daily steps. This suggests that participation in the intervention either increased activity not measured by the pedometer or resulted in decreased caloric consumption or both. Unfortunately, too few interventions specifically reported providing dietary counseling for us to include this factor in our analyses.

Pedometer users also significantly decreased their systolic blood pressure by almost 4 mm Hg from baseline. The magnitude of this finding is consistent with other published meta-analyses of the effects of physical activity on blood pressure.[46-50] Reducing systolic blood pressure by 2 mm Hg is associated with a 10% reduction in stroke mortality and a 7% reduction in mortality from vascular causes in middle-aged populations[51]; thus, it is critical that the effects of pedometer use on blood pressure be examined closely in future studies. Because blood pressure reductions were greatest among participants with the highest baseline blood pressure, this result may in part be due to regression to the mean. However, the overall reduction in blood pressure in the included studies is particularly interesting given that most of participants were normotensive at baseline—only 1 of our included studies targeted hypertensive patients.[20] Our finding that the reduction in systolic blood pressure was independent of decreases in BMI was consistent with the results of Whelton et al.[46] By highlighting the health benefits from physical activity exclusive of weight loss, health professionals may encourage patients who are frustrated by an inability to lose weight to engage in physical activity.

Our analyses reflect some limitations of the included studies. First, study sizes were relatively small and interventions were of relatively short duration and heterogeneous in their design. Second, few studies evaluated more than 1 of the outcomes of interest or provided detailed information about their participants. Third, because many interventions included the use of 2 or more components (eg, pedometers, step goals, diaries, counseling), the independent contribution of any one of these components is difficult to establish. Fourth, pedometers are used in these studies both as an intervention to motivate physical activity and as a tool to measure steps per day and participants may have increased their physical activity just by virtue of knowing that they are being monitored. However, this type of Hawthorne effect is likely to affect both intervention and control groups similarly. Finally, because only 5 studies involved participants with a mean age older than 60 years and only 15% of the participants were men, the generalizability of our results to older and male populations is limited.

Given these limitations, to fully elucidate the potential benefits of pedometers, large, randomized controlled trials of men and women over a range of ages in the outpatient setting is required. Such trials should make the following comparisons: (1) pedometer use in which participants can see their daily step counts vs pedometer use in which they are blinded to their daily step counts, (2) pedometer use with vs without a step goal, (3) pedometer use with vs without physical activity counseling and feedback (including face-to-face sessions and electronic feedback), and (4) pedometer use with vs without the use of step diaries. Key outcomes for such trials include both physical activity as well as detailed assessments of key health outcomes measured both in the short and longer term.

Despite the abundance of lay literature on the use of pedometers, our study is the first published synthesis of the evidence. Our results suggest that the use of these small, relatively inexpensive devices is associated with significant increases in physical activity and improvements in some key health outcomes, at least in the short term. The extent to which these results are durable over the long term is unknown.

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Acquisition of data: Bravata, Smith-Spangler, Sundaram, Gienger, Lin, Lewis, Stave, Sirard.

Analysis and interpretation of data: Bravata, Smith-Spangler, Gienger, Lin, Olkin, Sirard.

Drafting of the manuscript: Bravata, Smith-Spangler, Sirard.

Critical revision of the manuscript for important intellectual content: Bravata, Smith-Spangler, Sundaram, Gienger, Lin, Lewis, Stave, Olkin, Sirard.

Statistical analysis: Bravata, Olkin.

Obtained funding: Bravata.

Administrative, technical, or material support: Bravata, Smith-Spangler, Sundaram, Gienger, Lin, Lewis, Sirard.

Study supervision: Bravata, Sirard.

Library searches: Stave.

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REFERENCES

1. Alevizos A, Lentzas J, Kokkoris S, Mariolis A, Korantzopoulos P. Physical activity and stroke risk. *Int J Clin Pract.* 2005;59(8):922-930. FULL TEXT | ISI | PUBMED

2. Brown DR. Physical activity, ageing, and psychological well-being: an overview of the research. *Can J Sport Sci.* 1992;17(3):185-193. ISI | PUBMED

3. Speck BJ, Looney SW. Effects of a minimal intervention to increase physical activity in women: daily activity records. *Nurs Res.* 2001;50(6):374-378. FULL TEXT | ISI | PUBMED

4. Miller TD, Balady GJ, Fletcher GF. Exercise and its role in the prevention and rehabilitation of cardiovascular disease. *Ann Behav Med.* 1997;19(3):220-229. ISI | PUBMED

5. Surgeon General's healthy weight advice for consumers. http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_advice.htm. Accessed May 5, 2005.

6. Preventing obesity and chronic diseases through good nutrition and physical acivity. July 2005. http://www.cdc.gov/nccdphp/publications/factsheets/Prevention/obesity.htm. Accessed September 19, 2007.

7. Pedometers: walking by the numbers. *Consum Rep.* October 2004:30-31. PUBMED

8. Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? preliminary pedometer indices for public health. *Sports Med.* 2004;34(1):1-8. FULL TEXT | ISI | PUBMED

9. Hedges LV, Olkin I. *Statistical Methods for Meta-Analysis.* San Diego, CA: Academic Press; 1985.

10. Gleser L, Olkin I. Stochastically Dependent Effect Sizes. In: Cooper J, Hedges L, eds. *The Handbook of Research Synthesis.* New York, NY: Russel Sage Foundation; 1994:339-355.

11. Cooper H, Hedges L. *The Handbook of Research Synthesis.* New York, NY: Russell Sage Foundation; 1994.

12. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med.* 2002;21(11):1539-1558. FULL TEXT | ISI | PUBMED

13. Chan CB, Ryan DAJ, Tudor-Locke C. Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Prev Med.* 2004;39(6):1215-1222. FULL TEXT | ISI | PUBMED

14. Izawa KP, Watanabe S, Onvya K, et al. Effect of the self-monitoring approach on exercise maintenance during cardiac rehabilitation—a randomized, controlled trial. *Am J Phys Med Rehabil.* 2005;84(5):313-321. FULL TEXT | ISI | PUBMED

15. Kilmer DD, Wright NC, Aitkens S. Impact of a home-based activity and dietary intervention in people with slowly progressive neuromuscular diseases. *Arch Phys Med Rehabil.* 2005;86(11):2150-2156. FULL TEXT | ISI | PUBMED

16. Araiza P, Hewes H, Gashetewa C, Vella CA, Burge MR. Efficacy of a pedometer-based physical activity program on parameters of diabetes control in type 2 diabetes mellitus. *Metabolism.* 2006;55(10):1382-1387. FULL TEXT | ISI | PUBMED

17. Butler L, Dwyer D. Pedometers may not provide a positive effect on walking activity. *Health Promo J Australia.* 2004;15(2):134-136.

18. de Blok BMJ, de Greef MHG, ten Hacken NHT, Sprenger SR, Postema K, Wempe JB. The effects of a lifestyle physical activity counseling program with feedback of a pedometer during pulmonary rehabilitation in patients with COPD: a pilot study. *Patient Educ Couns.* 2006;61(1):48-55. FULL TEXT | ISI | PUBMED

19. Hultquist CN, Albright C, Thompson DL. Comparison of walking recommendations in previously inactive women. *Med Sci Sports Exerc.* 2005;37(4):676-683. FULL TEXT | ISI | PUBMED

20. Moreau KL, Degarmo R, Langley J, et al. Increasing daily walking lowers blood pressure in postmenopausal women. *Med Sci Sports Exerc.* 2001;33(11):1825-1831. FULL TEXT | ISI | PUBMED

21. Ransdell LB, Robertson L, Ornes L, Moyer-Mileur L. Generations exercising together to improve fitness (GET FIT): a pilot study designed to increase physical activity and improve health-related fitness in three generations of women. *Women Health.* 2004;40(3):77-94. ISI | PUBMED

22. Ornes LL, Ransdell LB, Robertson L, Trunnell E, Moyer-Mileur L. A 6-month pilot study of effects of a physical activity intervention on life satisfaction with a sample of three generations of women. *Percept Mot Skills.* 2005;100(3 pt 1):579-591. FULL TEXT | ISI | PUBMED

23. Talbot LA, Gaines JM, Huynh TN, Metter EJ. A home-based pedometer-driven walking program to increase physical activity in older adults with osteoarthritis of the knee: a preliminary study. *J Am Geriatr Soc.* 2003;51(3):387-392. FULL TEXT | ISI | PUBMED

24. Croteau KA. A preliminary study on the impact of a pedometer-based intervention on daily steps. *Am J Health Promot.* 2004;18(3):217-220. ISI | PUBMED

25. Eastep E, Beveridge S, Eisenman P, Ransdell L, Shultz B. Does augmented feedback from pedometers increase adults' walking behavior? *Percept Mot Skills.* 2004;99(2):392-402. ISI | PUBMED

26. Jensen GL, Roy MA, Buchanan AE, Berg MB. Weight loss intervention for obese older women: improvements in performance and function. *Obes Res.* 2004;12(11):1814-1820. **FREE** FULL TEXT

27. Koulouri AA, Tigbe WW, Lean ME. The effect of advice to walk 2000 extra steps daily on food intake. *J Hum Nutr Diet.* 2006;19(4):263-266. FULL TEXT | ISI | PUBMED

28. Lindberg R. Active living: on the road with the 10,000 steps program. *J Am Diet Assoc.* 2000;100(8):878-879. FULL TEXT | ISI | PUBMED

29. Schneider PL, Bassett DR Jr, Thompson DL, Pronk NP, Bielak KM. Effects of a 10,000 steps per day goal in overweight adults. *Am J Health Promot.* 2006;21(2):85-89. FULL TEXT | ISI | PUBMED

30. Sidman CL, Corbin CB, Le Masurier G. Promoting physical activity among sedentary women using pedometers. *Res Q Exerc Sport.* 2004;75(2):122-129. ISI | PUBMED

31. Stovitz SD, VanWormer JJ, Center BA, Bremer KL. Pedometers as a means to increase ambulatory activity for patients seen at a family medicine clinic. *J Am Board Fam Pract.* 2005;18(5):335-343. **FREE** FULL TEXT

32. Sugiura H, Kajima K, Mirbod SM, Iwata H, Matsuoka T. Effects of long-term moderate exercise and increase in number of daily steps on serum lipids in women: randomised controlled trial [ISRCTN21921919]. *BMC Womens Health.* 2002;2(1):3. FULL TEXT | PUBMED

33. Swartz AM, Strath SJ, Bassett DR, et al. Increasing daily walking improves glucose tolerance in overweight women. *Prev Med.* 2003;37(4):356-362. FULL TEXT | ISI | PUBMED

34. Thomas L, Williams M. Promoting physical activity in the workplace: using pedometers to increase daily

activity levels. *Health Promot J Aust.* 2006;17(2):97-102. PUBMED

35. Tudor-Locke C, Bell RC, Myers AM, et al. Controlled outcome evaluation of the First Step Program: a daily physical activity intervention for individuals with type II diabetes. *Int J Obes Relat Metab Disord.* 2004;28(1):113-119. FULL TEXT | ISI | PUBMED

36. VanWormer JJ, Boucher JL, Pronk NP, Thoennes JJ. Lifestyle behavior change and coronary artery disease: effectiveness of a telephone-based counseling program. *J Nutr Educ Behav.* 2004;36(6):333-324. FULL TEXT | ISI | PUBMED

37. Williams BR, Bezner J, Chesbro SB, Leavitt R. The effect of a behavioral contract on adherence to a walking program in postmenopausal African American women. *Top Geriatr Rehab.* 2005;21(4):332-342.

38. Wilson DB, Porter JS, Parker G, Kilpatrick J. Anthropometric changes using a walking intervention in African American breast cancer survivors: a pilot study. *Prev Chronic Dis.* 2005;2(2):A16. PUBMED

39. Wyatt HR, Peters JC, Reed GW, et al. Using electronic step counters to increase lifestyle physical activity: Colorado on the Move. *J Phys Act Health.* 2004;1(3). 181-191.

40. Hillsdon M, Foster C, Thorogood M. Interventions for promoting physical activity. *Cochrane Database Syst Rev.* 2005(1):CD003180. PUBMED

41. Schneider PL, Crouter SE, Lukajic O, Bassett DR Jr. Accuracy and reliability of 10 pedometers for measuring steps over a 400-m walk. *Med Sci Sports Exerc.* 2003;35(10):1779-1784. FULL TEXT | ISI | PUBMED

42. Crouter SE, Schneider PL, Karabulut M, Bassett DR Jr. Validity of 10 electronic pedometers for measuring steps, distance, and energy cost. *Med Sci Sports Exerc.* 2003;35(8):1455-1460. FULL TEXT | ISI | PUBMED

43. Le Masurier GC, Tudor-Locke C. Comparison of pedometer and accelerometer accuracy under controlled conditions. *Med Sci Sports Exerc.* 2003;35(5):867-871. FULL TEXT | ISI | PUBMED

44. Bassett DR Jr, Ainsworth BE, Leggett SR, et al. Accuracy of five electronic pedometers for measuring distance walked. *Med Sci Sports Exerc.* 1996;28(8):1071-1077. ISI | PUBMED

45. Eden KB, Orleans CT, Mulrow CD, Pender NJ, Teutsch SM. Does counseling by clinicians improve physical activity? a summary of the evidence for the US Preventive Services Task Force. *Ann Intern Med.* 2002;137(3):208-215. **FREE** FULL TEXT

46. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. *Ann Intern Med.* 2002;136(7):493-503. **FREE** FULL TEXT

47. Murphy MH, Nevill AM, Murtagh EM, Holder RL. The effect of walking on fitness, fatness and resting blood pressure: a meta-analysis of randomised, controlled trials. *Prev Med.* 2007;44(5):377-385. FULL TEXT | ISI | PUBMED

48. Kelley GA, Kelley KS, Tran ZV. Walking and resting blood pressure in adults: a meta-analysis. *Prev Med.* 2001;33(2 pt 1):120-127. ISI | PUBMED

49. Halbert JA, Silagy CA, Finucane P, Withers RT, Hamdorf PA, Andrews GR. The effectiveness of exercise training in lowering blood pressure: a meta-analysis of randomised controlled trials of 4 weeks or longer. *J Hum Hypertens.* 1997;11(10):641-649. FULL TEXT | ISI | PUBMED

50. Kelley G, Tran ZV. Aerobic exercise and normotensive adults: a meta-analysis. *Med Sci Sports Exerc.* 1995;27(10):1371-1377. ISI | PUBMED

51. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet.* 2002;360(9349):1903-1913. FULL TEXT | ISI | PUBMED

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