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Interventions to Increase Walking Behavior

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Abstract

Walking is the most prevalent and preferred method of physical activity for both work and leisure purposes, thus making it a prime target for physical activity promotion interventions. We identified 14 randomized controlled trials, which tested interventions specifically targeting and assessing walking behavior. Results show that among self-selected samples intensive interventions can increase walking behavior relative to controls. Brief telephone prompts appear to be as effective as more substantial telephone counseling. Although more research is needed, individual studies support prescriptions to walk 5–7 d/wk versus 3–5 d/wk and at a moderate (versus vigorous) intensity pace, with no differences in total walking minutes when single or multiple daily walking bouts are prescribed. Mediated interventions delivering physical activity promotion materials through non-face-to-face channels may be ideal for delivering walking promotion interventions and have shown efficacy in promoting overall physical activity, especially when theory-based and individually tailored. Mass media campaigns targeting broader audiences, including those who may not intend to increase their physical activity, have been successful at increasing knowledge and awareness about physical activity, but are often too diffuse to successfully impact individual behavior change. Incorporating individually tailored programs into broader mass media campaigns may be an important next step, and the Internet could be a useful vehicle.

Keywords

Walking; Physical Activity; Exercise; Mediated Interventions; Behavior Change

Walking is the most frequently reported activity in surveys of leisure-time physical activity [54,58], and is associated with numerous health benefits [25]. Surveillance estimates among U.S. adults indicate that about 30% of men and 47% of women report walking in their leisure time, and about 50% report walking at least 3 d/wk for 30 min/occasion, or about 1.5 hrs/wk [55]. However, if one considers walking done at home, work, and during leisure-time; about 80% of adults in the United States report walking for 10 minutes at a time on at least 1 d/wk [2]. In this survey of U.S. adults, the median duration reported for purposeful walking for any reason was about 4hrs/wk. Objective estimates of walking behavior in the U.S. population

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indicate that adults accumulate 6000–7000 steps/d on average [57,59]. In contrast, sub-groups of North American adults who do not use the full complement of labor saving devices in their daily lives routinely accumulate 15–20,000 steps/d [1]. In summary, walking is a highly prevalent form of activity that can be done at work, home, and during leisure-time which makes this form of activity a logical choice for intervention efforts [24,27].

While researchers have made great strides in understanding the impact of physical activity on biological mechanisms that influence the natural history of chronic diseases, the current challenge is to continue to develop intervention programs that successfully target the psychological and social-ecological mechanisms that mediate and moderate the adoption and maintenance of physical activity. The purpose of this paper is to review studies of walking promotion interventions. Non-face-to-face (i.e., mediated) interventions are also briefly discussed, given their good fit for delivering home-based walking programs.

Methods

We searched Pubmed and PsychInfo databases for studies from 1980 forward that included the word “walk” (including, for example, “walking,” “walkers”) in the study title. Study titles and abstracts were scanned. Because we wanted to distinguish walking promotion interventions from more general physical activity interventions, full text articles were obtained only for studies that specifically examined the effects of a walking promotion intervention on walking behavior change. Studies that measured walking outcomes, but did not exclusively target walking behavior [e.g., 45] were not included. Additionally, a number of studies that tested the effects of a walking program on one or more targeted health outcomes (e.g., obesity), were not included in this review if control groups were explicitly asked not to increase their walking [e.g., 13,42]. In addition to our database search, we searched references from articles obtained via the search methods above and reference sections from other reviews of physical activity promotion interventions [e.g., 18,21,38] and retrieved articles if they met the above inclusion criteria. Through this process, we obtained additional studies of walking interventions that did not include the word “walk” in the study title. Specifically, we located 14 randomized controlled trials (RCTs) that randomized individual participants to one or more walking interventions and/or a control condition and examined walking behavior outcomes (Table 1). These studies are the focus of our review.

Walking Promotion Interventions

We found three RCTs that tested the efficacy of walking promotion programs versus a control condition that did not include a physical activity program [23,44,49,56]. Kriska and colleagues [23] found greater walking behavior at one and two years, relative to no-treatment controls, among healthy postmenopausal women who received an intensive 8-week face-to-face walking program, followed by continued face-to-face contact if desired, plus frequent phone prompts and monthly newsletters over 24 months. A follow-up analysis conducted 10 years after the end of the initial 24-month period found that women in the treatment condition continued to walk significantly more than controls and significantly more than initial baseline values [49]. Similarly, Mutrie and colleagues [44] found that previously inactive UK worksite employees who received a packet of print materials, including theory-based physical activity promotion booklets and maps highlighted with possible waking routes to each participant’s worksite, were almost twice as likely to be walking to work 6 months later compared to participants in a wait-list control condition. A third trial, conducted by Talbot and colleagues [56] found significant increases in walking among adults over age 60 with diagnosed osteoarthritis of the knee who were given three brief walking promotion counseling sessions every four weeks over a 12-week period compared to participants who received arthritis education only. The walking increases were not maintained, however, at 24 weeks. Taken together, the findings show that

intensive walking interventions can increase walking behavior relative to no treatment, with one trial showing long-term maintenance of walking increases among healthy women.

All of the other RCTs that we found tested the efficacy of one or more aspects of a walking program against other walking programs that varied with respect to the intervention components [8–11,19–20,28,47,50,53]. The greatest number of studies examined the efficacy of telephone prompts as an intervention adjunct or as the primary intervention (47, 20, 10, 28). Humpel and colleagues [20] found no additional benefit of three weekly telephone counseling sessions when added to print materials distributed over the same 3-week period among adult clients of an Australian healthcare organization [20]. However, both groups had significantly increased walking at the time assessments were conducted – one-month following the end of the 3-week intervention – and because there was no assessment immediately post-treatment, it is not clear whether there were group differences at that time. Three additional studies each included a treatment arm that received brief physical activity counseling and/or educational materials at baseline only and compared this minimal treatment to multiple additional treatment arms receiving the minimal treatment plus different frequencies, durations, or types of phone prompts [47,10,28]. Nies and colleagues [47] found increases in walking that were not different from the minimal intervention group among women receiving short-duration telephone prompts or an equal number of longer-duration telephone counseling sessions. In a 2×2 design plus a minimal intervention group, Lombard and colleagues [28] found that receiving telephone prompts, versus no prompts, and receiving more frequent prompts resulted in greater increases in walking behavior among women, although, consistent with Nies and colleagues, [47] prompt duration (i.e., prompts versus counseling) had no effect on walking outcomes. Interestingly, Dubbert and colleagues [10] found larger increases in walking among older men (60–80 years) receiving 10 personal and 10 automated phone prompts than participants receiving baseline counseling alone; however, no differences were found between men receiving 20 personal phone prompts and men in the baseline counseling condition. Findings from these studies provide preliminary evidence that telephone prompts may be helpful in increasing walking behavior, and that number of contacts may be more important than type or duration (i.e., counseling versus brief prompt) of contacts. More research is needed though, given some null effects of phone prompts [i.e., 47] and issues concerning personal versus automated prompts [10] and potential difference by gender.

In addition to phone prompting, two RCTs tested the efficacy of using pedometers as a motivational tool and setting goals in terms of steps taken versus minutes walked [11,19]. Hultquist and colleagues [19] found greater increases in walking among participants using pedometers to set step-based goals compared to a no pedometer, minute-based goal-setting group, whereas Engel and colleagues [11] found no difference between groups in a similarly designed study. A number of differences in the two study designs, however, may account for the different study outcomes. Hultquist et al. [19] assessed walking among middle-aged women (33–55 years) over 4 weeks with pedometers as the primary outcome measure, whereas Engel et al. [11] assessed walking among older men (50–70 years) over 6 months, with self-reported time spent walking as the primary outcome measure. Moreover, in the Engel et al. [11] study, treatment for both groups was more substantial, involving individualized counseling and tailored goal setting, while in the Hultquist et al. [19] study treatment involved a minimal contact intervention and goals based on national recommendations (i.e., 10,000 steps or 30 minutes per day). Thus, the more substantial intervention and individually tailored goals may have led to a lack of differences in the Engel [11] study. More research is needed to determine the efficacy of pedometers as a motivational tool, including potential moderators such as age, gender, and goal type.

Two RCTs examined the effects of various exercise prescriptions on walking behavior. In a 2×2 design, Perri and colleagues [50] found that prescriptions for walking at a higher frequency

(5–7 days/week versus 3–5 days/week) and moderate intensity (versus vigorous intensity) resulted in more total minutes of walking among healthy adults. Complimentary to these findings, Coleman and colleagues [9] found no differences in increased walking among healthy adults who were asked to walk 30 min/day 6 days/week via either 30-minute continuous sessions, three 10-minute sessions/day, or sessions of any duration as long as they were at least 5 minutes in duration and summed to 30 min/day. Taken together, these studies indicate that prescribing high frequency moderate intensity walking is most effective at increasing minutes of walking, but that daily walking can be accomplished in one or multiple bouts.

Finally, two RCTs compared interventions that differed with respect to their theoretical basis. Chen and colleagues [8] found that among racial-ethnic minority women, an intensive, individually tailored, theory-based intervention resulted in similar increases in walking at 2 months and 30 months, compared to a less intensive intervention that was not theoretically based. Surprisingly, the participants in the standard intervention walked more at 5 months than participants in the more intensive, theory-based intervention. Rovniak and colleagues [53] tested a theory-based 12-week intervention using specific modeling, goal-setting, self-monitoring, and performance feedback compared to a standard intervention using similar techniques and number of contacts, but without specific theory-based content. There were no differences in walking increases at 12 weeks, but there was a trend for more walking among the theory-based group at the one-year follow-up. More RCTs, similar to the Rovniak [53] study, that control for contact time, but have larger sample sizes, are needed to test the efficacy of theory-based walking programs.

Mediated Interventions as a Vehicle for Walking Programs

A number of walking programs have used telephone prompts or telephone counseling to deliver walking promotion interventions [8,10,11,20,28,47]. These programs are often referred to as mediated interventions, because they deliver intervention content through non-face-to-face media. In addition to telephone, mediated interventions can be delivered via print or using information technology (i.e., Email, Internet) [37,41,45,53]. Mediated interventions can be particularly helpful for promoting walking, as brisk walking is a form of physical activity that is of moderate intensity, thus for most people it can be performed without face-to-face supervision, special equipment or special physician clearance. Moreover, mediated interventions can save time by reducing or eliminating face-to-face contact, but can also provide information and support at the level that would normally be available only through face-to-face contact with an exercise specialist [36,37,39,41]. This is especially important since lack of time and resources are the most often cited barriers to the adoption and maintenance of regular physical activity [31].

In addition to the few studies of mediated walking interventions [8,10,11,20,28,47,53], several studies have examined mediated interventions that promote overall physical activity, rather than walking per se. Some programs have offered tailored, mediated physical activity programs based on theoretical models. Such interventions, which are sometimes delivered via a *computer expert system*, offer motivational tips and advice based on complex algorithms that account for each individual's standing on a number of theory-based variables. Thus, participants enrolled in expert system driven interventions receive theory-based "counseling" in the context of a home-based, worksite-based, or primary-care-based physical activity program [14,30, 32]. Print and telephone-based interventions for physical activity, particularly those that have been shaped by theoretical perspectives such as Social Cognitive Theory and the Transtheoretical Model have been effective for promoting physical activity [6,30,32,34,28, 33,34]. These effects have been found in trials in which the recruitment was done in the community [22] as well as in primary care settings [15]. Additionally, there have been a few studies that have examined Internet/Email alone or compared with print with mixed results.

Two studies found no increases in physical activity among participants receiving an Internet physical activity promotion program [16,40], while a third showed increases in self-reported walking relative to a control condition, but not increases in overall physical activity [45]. In one of the studies showing no increases in physical activity only 46% of participants reported visiting the website during the study period [26]. In a recently completed study that used various features in an attempt to increase website usage, physical activity increased significantly and similarly among participants receiving Internet and print interventions [33].

Individual level interventions have been shown to be effective at increasing physical activity, but they only affect a small percentage of the population. Mass media campaigns, however, are able to reach a large number of individuals over a relatively short time period. Increasing walking is an ideal campaign message, since walking can be performed, unsupervised, by most individuals. Although mass media campaigns do not lend themselves to RCTs, a few recent mass media campaigns specifically targeting walking behavior were examined through quasi-experimental designs. One community wide intervention targeted 50 to 65 year-old sedentary adults living in a rural community in West Virginia [51,52]. The 8-week intervention combined elements of mass media and individualized intervention components, including paid advertising, public relations, community participatory planning, work site programs, and physician-based programs. A similar, 4-week campaign was delivered at 11 months. A comparison community was located in the same geographic region and had a similar population in terms of size and demographics, but did not receive any intervention. Random digit dial telephone surveys were conducted on a sub-sample in each community. Among adults who were sedentary at baseline, 32% met CDC/ACSM criteria (at least 150 minutes accumulated over at least 5 days per week) at the 8-week assessment in the intervention community, versus 18% meeting these criteria in the comparison community. These relative increases were maintained at 12-month follow-up, with the intervention community members who were sedentary at baseline almost twice as likely to be meeting CDC/ACSM criteria at 12 months compared to the comparison community [52].

Another series of community wide campaigns designed to promote walking was conducted in six rural Missouri communities with comparison communities in Arkansas and Tennessee that were matched on size, poverty level, and percentage of African-Americans [4,5]. The intervention included tailored newsletters sent to individuals who enrolled in the program, walking groups, physician-based programs, and community events. There were also 6 walking trails constructed in the Missouri communities and two of them had counting devices to track trail use. Some community members also received cards that allowed the research team to provide tailored feedback based on their own personal use of the trail. Results, however, indicated a slight decline in walking in the intervention communities relative to the comparison communities, although there was a non-significant trend indicating that individuals who received a higher dose of the intervention (combination of participating in various aspects of the intervention) were more likely to meet recommendations.

Similar to the campaigns conducted by Brownson and colleagues that specifically targeted walking behavior [4,5], reviews of mass media campaigns attempting to promote overall physical activity show that, in the absence of additional components, most do not lead to population level increases in physical activity [7,12,21,37,41]. Additionally, many studies of mass media interventions do not include a control group, so even if changes are noted they cannot unequivocally be attributed to the mass media campaign and may be due to secular trends or other events occurring in the community at that time [17,43]. Moreover, while recall of the awareness for many mass media campaigns has been fairly high, it is important to keep in mind that 15–20% of individuals will report recall of a campaign even before it has started [3]. Nonetheless, more research is needed on mass media campaigns as a means for delivering walking promotion and overall physical activity programs, as they have the potential to

successfully introduce new ideas, reinforce messages, attract attention, affect important antecedents of physical activity (knowledge, beliefs, intentions, social norms, attitudes, etc.) and act as a supplement to other interventions that are occurring in the community [7,29,48].

Summary and Conclusions

Increased walking on a population level has the potential to significantly decrease incidence of chronic disease (Lee et al., 2001). However, in order for this process to be set into motion, interventions must effectively promote walking behavior. Although few walking programs have been studied in the context of an RCT, findings show some promise for intensive walking promotion interventions relative to control groups (23, 44, 56), even over follow-up periods as long as 10-years (49). Findings from studies examining various components of walking interventions have shown that brief telephone prompts may be helpful in increasing walking behavior (28), and that prescribing moderate intensity walking 5–7 days per week (50) in either single or multiple sessions per day (9) may be most effective for increasing minutes of walking. Preliminary evidence indicates that walking programs that are carefully tied to theoretical frameworks may be superior to atheoretical programs or programs based loosely based on theory (53). More research is needed to determine the relative efficacy of various theoretical models, as well as the usefulness of programs based on multiple theoretical models.

Mediated interventions help circumvent the barriers of time and resources often associated with traditional face-to-face interventions (46). Mediated interventions that operate on the level of the individual have shown some success, especially when theory-based and tailored to individuals needs (30, 32–34). Mass media campaigns often raise awareness, but typically do not produce behavior change on a population level [12]. One mass media campaign that did increase walking behavior used both mass media and face-to-face approaches, such as physician counseling and worksite programs [51,52]. This highlights the potential benefit of combining mass media campaigns with more intensive intervention approaches One avenue yet to be pursued is combining the strengths of mediated intervention approaches that operate at the individual and population levels. While mediated interventions focusing on individual change are usually able to provide more intensive programs, they often lack the broad reach of mass media campaigns. This is usually because of the high costs associated with delivering an intensive, individually tailored campaign on a population level. However, Internet-based, expert system-driven programs have the potential to be highly cost-effective. Although relatively high costs are associated with initial development of expert systems and websites, incremental costs of program delivery to each additional user are small or non-existent. Recent findings have shown some promise for changing physical activity patterns through Internet-based, individually tailored mediated interventions [33]; however, additional research will be needed to successfully market and deliver these programs on a population level. Despite these challenges, theory-driven, mediated physical activity promotion programs show excellent promise for increasing walking behavior on a public-health scale.

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References

1. Bassett DR, Schneider PL, Huntington GE. Physical activity in an Old Order Amish community. Med Sci Sports Exerc 2004;36:79–85. [PubMed: 14707772]

2. Bates JH, Serdula MK, Khan LK, Jones DA, Gillespie C, Ainsworth BE. Total and leisure-time walking among U.S. adults should every step count? Am J Prev Med 2005;29:46–50. [PubMed: 15958251]
3. Bauman AE, Bellew B, Owen N, Vita P. Impact of an Australian mass media campaign targeting physical activity in 1998. Am J Prev Med 2001;21:41–47. [PubMed: 11418256]
4. Brownson RC, Baker EA, Boyd RL, et al. A community-based approach to promoting walking in rural areas. Am J Prev Med 2004;27(1):28–34. [PubMed: 15212772]
5. Brownson RC, Hagood L, Lovegreen SL, et al. A multilevel ecological approach to promoting walking in rural communities. Prev Med 2005;41(5–6):837–842. [PubMed: 16256183]
6. Castro CM, King AC. Telephone-assisted counseling for physical activity. Exerc Sport Sci Rev 2002;30:64–68. [PubMed: 11991539]
7. Cavill N, Bauman A. Changing the way people think about health-enhancing physical activity: do mass media campaigns have a role? J Sports Sci 2004;22:771–790. [PubMed: 15370487]
8. Chen AH, Sallis JF, Castro CM, et al. A home-based behavioral intervention to promote walking in sedentary ethnic minority women: project WALK. Womens Health 1998;4(1):19–39. [PubMed: 9520605]
9. Coleman KJ, Raynor HR, Mueller DM, Cerny FJ, Dorn JM, Epstein LH. Providing sedentary adults with choices for meeting their walking goals. Prev Med 1999;28(5):510–519. [PubMed: 10329342]
10. Dubbert PM, Cooper KM, Kirchner KA, Meydrech EF, Bilbrew D. Effects of nurse counseling on walking for exercise in elderly primary care patients. J Gerontol A Biol Sci Med Sci 2002;57 (11):M733–740. [PubMed: 12403802]
11. Engel L, Lindner H. Impact of using a pedometer on time spent walking in older adults with type 2 diabetes. Diabetes Educ 2006;32(1):98–107. [PubMed: 16439498]
12. Finlay SJ, Faulkner G. Physical activity promotion through the mass media: inception, production, transmission and consumption. Prev Med 2005;40:121–130. [PubMed: 15533520]
13. Fogelholm M, Kukkonen-Harjula K, Nenonen A, Pasanen M. Effects of walking training on weight maintenance after a very-low-energy diet in premenopausal obese women: a randomized controlled trial. Arch Intern Med 2000;160(14):2177–2184. [PubMed: 10904461]
14. Goldstein MG, Pinto BM, Marcus BH, et al. Physician-based physical activity counseling for middle-aged and older adults: a randomized trial. Ann Behav Med 1999;21:40–47. [PubMed: 18425653]
15. Green BB, McAfee T, Hindmarsh M, Madsen L, Caplow M, Buist D. Effectiveness of telephone support in increasing physical activity levels in primary care patients. Am J Prev Med 2002;22:177–183. [PubMed: 11897462]
16. Hageman PA, Walker SN, Pullen CH. Tailored versus standard internet-delivered interventions to promote physical activity in older women. J Geriatr Phys Ther 2005;28:28–33. [PubMed: 16236225]
17. Hillsdon M, Cavill N, Nanchahal K, Diamond A, White IR. National level promotion of physical activity: results from England's ACTIVE for LIFE campaign. J Epidemiol Community Health 2001;55:755–761. [PubMed: 11553661]
18. Hillsdon M, Foster C, Thorogood M. Interventions for promoting physical activity. Cochrane Database Syst Rev 2005:CD003180. [PubMed: 15674903]
19. Hultquist CN, Albright C, Thompson DL. Comparison of walking recommendations in previously inactive women. Med Sci Sports Exerc 2005;37(4):676–683. [PubMed: 15809569]
20. Humpel N, Marshall AL, Iverson D, Leslie E, Owen N. Trial of print and telephone delivered interventions to influence walking. Prev Med 2004;39:635–641. [PubMed: 15313106]
21. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med 2002;22:73–107. [PubMed: 11985936]
22. King AC, Friedman F, Marcus B, et al. Physical activity advice by humans versus computers: the Community Health Advice by Telephone (CHAT) trial. under review
23. Kriska AM, Bayles C, Cauley JA, LaPorte RE, Sandler RB, Pambianco G. A randomized exercise trial in older women: increased activity over two years and the factors associated with compliance. Med Sci Sports Exerc 1986;18(5):557–562. [PubMed: 3534509]
24. Lanningham-Foster L, Nysse LJ, Levine JA. Labor saved, calories lost: the energetic impact of domestic labor-saving devices. Obes Res 2003;11:1178–1181. [PubMed: 14569042]

25. Lee IM, Rexrode KM, Cook NR, Manson JE, Buring JE. Physical activity and coronary heart disease in women: Is “no pain, no gain” passe? JAMA 2001;285(11):1447–1454. [PubMed: 11255420]
26. Leslie E, Marshall AL, Owen N, Bauman A. Engagement and retention of participants in a physical activity website. Prev Med 2005;40:54–59. [PubMed: 15530581]
27. Levine JA, Lanningham-Foster LM, McCrady SK, et al. Interindividual variation in posture allocation: possible role in human obesity. Science 2005;307:584–586. [PubMed: 15681386]
28. Lombard DN, Lombard TN, Winett RA. Walking to meet health guidelines: the effect of prompting frequency and prompt structure. Health Psychol 1995;14(2):164–170. [PubMed: 7789352]
29. Malibach, EW.; Rothschild, M.; Novelli, W. Social marketing. In: Glanz, K.; Rimmer, F.; Lewis, FM., editors. Health Behavior and Health Education. St. Louis, MO: Mosby; 2002. p. 437-461.
30. Marcus BH, Bock BC, Pinto BM, Forsyth LH, Roberts MB, Traficante RM. Efficacy of an individualized, motivationally-tailored physical activity intervention. Ann Behav Med 1998;20:174–180. [PubMed: 9989324]
31. Marcus, BH.; Dubbert, PM.; King, AC.; Pinto, BM. Physical activity in women: current status and future directions. In: Stanton, A.; Gallant, S., editors. Women’s Health. American Psychological Association; 1995.
32. Marcus BH, Emmons KM, Simkin-Silverman LR, et al. Evaluation of motivationally tailored vs. standard self-help physical activity interventions at the workplace. Am J Health Promot 1998;12:246–253. [PubMed: 10178617]
33. Marcus BH, Lewis BA, Williams DM, et al. A comparison of internet and print-based physical activity interventions. Arch Intern Med. in press
34. Marcus BH, Napolitano MA, King AC, et al. Telephone versus print delivery of an individualized motivationally-tailored physical activity intervention: Project STRIDE. Health Psychol. in press
35. Marcus BH, Napolitano M, Lewis B, et al. Examination of print and telephone channels for physical activity promotion: Rationale, design, and baseline data from project STRIDE. Contemporary Clinical Trials 2007;28(1):90–104. [PubMed: 16839823]
36. Marcus BH, Nigg CR, Riebe D, Forsyth LH. Interactive communication strategies: implications for population-based physical-activity promotion. Am J Prev Med 2000;19:121–126. [PubMed: 10913903]
37. Marcus BH, Owen N, Forsyth LH, Cavill NA, Fridinger F. Physical activity interventions using mass media, print media, and information technology. Am J Prev Med 1998;15:362–378. [PubMed: 9838978]
38. Marcus BH, Williams DM, Dubbert PM, et al. Physical activity intervention studies: what we know and what we need to know. Circulation 2006;114(24):2739–2752. [PubMed: 17145995]
39. Marshall AL, Bauman AE, Owen N, Booth ML, Crawford D, Marcus BH. Reaching out to promote physical activity in Australia: a statewide randomized controlled trial of a stage-targeted intervention. Am J Health Promot 2004;18:283–287. [PubMed: 15011926]
40. Marshall AL, Leslie ER, Bauman AE, Marcus BH, Owen N. Print versus website physical activity programs: a randomized trial. Am J Prev Med 2003;25:88–94. [PubMed: 12880874]
41. Marshall AL, Owen N, Bauman AE. Mediated approaches for influencing physical activity: update of the evidence on mass media, print, telephone and website delivery of interventions. J Sci Med Sport 2004;7:74–80. [PubMed: 15214605]
42. Matthews CE, Wilcox S, Hanby CL, et al. Evaluation of a 12-week home-based walking intervention for breast cancer survivors. Support Care Cancer. 2006
43. Miles A, Rapoport L, Wardle J, Afuape T, Duman M. Using the mass-media to target obesity: an analysis of the characteristics and reported behaviour change of participants in the BBC’s ‘Fighting Fat, Fighting Fit’ campaign. Health Educ Res 2001;16:357–372. [PubMed: 11497118]
44. Mutrie N, Carney C, Blamey A, Crawford F, Aitchison T, Whitelaw A. “Walk in to Work Out”: a randomised controlled trial of a self help intervention to promote active commuting. J Epidemiol Community Health 2002;56(6):407–412. [PubMed: 12011193]
45. Napolitano MA, Fotheringham M, Tate D, et al. Evaluation of an internet-based physical activity intervention: a preliminary investigation. Ann Behav Med 2003;25:92–99. [PubMed: 12704010]
46. Napolitano MA, Marcus BH. Targeting and tailoring physical activity information using print and information technologies. Exerc Sport Sci Rev 2002;30:122–128. [PubMed: 12150571]

47. Nies MA, Partridge T. Comparison of 3 interventions to increase walking in sedentary women. Am J Health Behav 2006;30(4):339–352. [PubMed: 16787125]

48. Owen N, Bauman A, Booth M, Oldenburg B, Magnus P. Serial mass-media campaigns to promote physical activity: reinforcing or redundant? Am J Public Health 1995;85:244–248. [PubMed: 7856786]

49. Pereira MA, Kriska AM, Day RD, Cauley JA, LaPorte RE, Kuller LH. A randomized walking trial in postmenopausal women: effects on physical activity and health 10 years later. Arch Intern Med 1998;158(15):1695–1701. [PubMed: 9701104]

50. Perri MG, Anton SD, Durning PE, et al. Adherence to exercise prescriptions: effects of prescribing moderate versus higher levels of intensity and frequency. Health Psychol 2002;21(5):452–458. [PubMed: 12211512]

51. Reger B, Cooper L, Booth-Butterfield S, et al. Wheeling Walks: a community campaign using paid media to encourage walking among sedentary older adults. Prev Med 2002;35(3):285–292. [PubMed: 12202072]

52. Reger-Nash B, Bauman A, Booth-Butterfield S, et al. Wheeling walks: evaluation of a media-based community intervention. Fam Community Health 2005;28(1):64–78. [PubMed: 15625507]

53. Rovniak LS, Anderson ES, Winett RA, Stephens RS. Social cognitive determinants of physical activity in young adults: A prospective structural equation analysis. Annals of Behavioral Medicine 2003;24:149–156. [PubMed: 12054320]

54. Siegel PZ, Brackbill RM, Heath GW. The epidemiology of walking for exercise: implications for promoting activity among sedentary groups. Am J Public Health 1995;85:706–710. [PubMed: 7733433]

55. Simpson ME, Serdula M, Galuska DA, et al. Walking trends among U.S. adults: the Behavioral Risk Factor Surveillance System, 1987–2000. Am J Prev Med 2003;25:95–100. [PubMed: 12880875]

56. 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. [PubMed: 12588583]

57. Tudor-Locke C, Ham SA, Macera CA, et al. Descriptive epidemiology of pedometer-determined physical activity. Med Sci Sports Exerc 2004;36:1567–1573. [PubMed: 15354039]

58. U.S. Department of Health and Human Services. Physical Activity and Health: a Report of the Surgeon General. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.

59. Wyatt HR, Peters JC, Reed GW, Barry M, Hill JO. A Colorado statewide survey of walking and its relation to excessive weight. Med Sci Sports Exerc 2005;37:724–730. [PubMed: 15870624]

Table 1

Randomized Controlled Studies of Interventions to Increase Walking Behavior.

First Author& Year	Participants	N	Intervention	Walking Measure	Outcome
Engel 2006	US Adults, 50–70 y/o, healthy, inactive, study completers (n = 50)	57	Monthly in-person or telephone counseling, plus: **a.** Pedometer/step-based goal setting **b.** Minute-based goal setting	Self-report journal	Both groups increased min walked over the 3-month intervention period, and maintained these gains at 6 months; no between group differences after controlling for baseline covariates
Nies 2006	US Women, 30–60 y/o, healthy, inactive, study completers (n = 253)	313	Recommendation to walk at least 90 min/ week, plus: **a.** Telephone counseling (16 total calls) **b.** Brief telephone call (16 total calls) **c.** Education (20-min video at baseline)	Self-report questionnaire	Increase in min walked in all 3 groups from baseline to 6-months and baseline to 12-months; no between group differences
Hultquist 2005	US Women, 33–55 y/o, healthy, inactive, study completers (n = 58)	62	Recommendations: **a.** Brisk 30-min walk on most days/ week **b.** 10,000 steps/day	Pedometers	Both groups increased walking over the 4- week intervention; group *b* walked more than group *a*
Rovniak 2005	US Women, 20–54 y/o, healthy, inactive, study completers (n = 50)	61	Walk 90 minutes per week; Weekly e-mail counseling, plus: **a.** Theory-based and specific modeling, goal-setting, self-monitoring, and performance feedback **b.** Same concepts delivered, but less specific, not theory-based	Self-report journal and questionnaire	Both groups increased walking over the 12- week intervention; increases were similar at 12-weeks; increases were greater (based on effect-size) for group *a* than group *b* at one year follow-up
Humpel 2004	Australian Adults, 40+ y/o, clients of a health care organization	399	**a.** Mailing of self-help print materials over 3 weeks **b.** Same print materials plus 3 weekly telephone counseling sessions	Self-report questionnaire	Both groups increased walking behavior at 8–10 weeks (about 1 month post- intervention); no between group differences
Talbot 2003	US Adults, 60+ y/o, osteoarthritis of the knee, otherwise healthy	34	**a.** Arthritis education **b.** Arthritis education plus 3 monthly face-to-face counseling sessions	Pedometers	Within group increases in walking for group *b* only at 12 weeks; group *b* walked more than group *a* at 12 weeks; no within or between group differences at 24 weeks

First Author& Year	Participants	N	Intervention	Walking Measure	Outcome
Dubbert 2002	US Men (99%), 60–80 y/o, healthy, inactive, study completers (n = 181)	212	Brief baseline counseling, plus: **a.** 20 personal phone calls **b.** 10 personal + 10 automated phone calls **c.** No phone calls	Self-report journals	All groups increased walking over 10 months; group *b* walked more than group *c*; group *a* did not differ from *b* or *c*
Mutrie 2002	UK healthcare, business, and university employees, 19–69 y/o, inactive	295	**a.** Packet of theory-based print materials distributed at baseline intended to promote active commuting **b.** Wait-list control	Self-report questionnaire	Group *a* reported greater increases in walking to work than group *b* at 6 months; within group changes in control group were not reported
Perri 2002	US Adults, 30–69 y/o, healthy, inactive	399	Group-based, face-to-face counseling; 11 sessions over 6 months; walking prescription varied: **a.** Moderate intensity, moderate frequency **b.** Moderate intensity, high frequency **c.** High intensity, moderate frequency **d.** High intensity, high frequency	Self-report journals	Results showed significantly more walking for moderate intensity versus high intensity and for high frequency versus low frequency prescriptions
Coleman 1999	US Adults, 18–55 y/o, healthy, inactive, study completers (n = 32)	36	Weekly face-to-face counseling over 16 weeks; recommendation was 30 minutes/day, 6 days/week, with bouts of: **a.** 1 30-min session/day **b.** 3 10-min sessions/day **c.** Choice of session number, at least 5 min/session	Self-report journals	All groups increased walking over 16 weeks; no between group differences on walking
Pereira* 1998	US Women, postmenopausal, 50–65 y/o, healthy, agreed to follow- up (n = 196)	229	**a.** Walking groups 2x/week for 8 weeks; continued walking with group or on own for 2 years; face-to-face counseling; telephone prompts; monthly newsletters **b.** No-treatment	Self-report questionnaire	Group *a* walked more than group *b* 10 years after the end of the initial 2-year trial; Group *a* walked more than baseline levels from the initial trial; Group *b* did not increase walking
Chen 1998	US Women, racial-ethnic minority, 23–54 y/o, healthy, inactive, study completers (n = 105)	128	**a.** 8-week behavioral-based print and weekly individually tailored telephone counseling	Self-report questionnaire	Both groups showed increased walking relative to baseline at 2, 5, and 30 months; no differences between groups at 2 and 30

First Author& Year	Participants	N	Intervention	Walking Measure	Outcome
			b. Standard print materials and one brief educational telephone call		months; group *b* walked more than group *a* at 5 months
Lombard 1995	US Women (98%), 21–63 y/o, healthy	135	Baseline 15-minute counseling and print handout plus 12-weeks of prompts: **a.** No prompts **b.** High frequency, low structure **c.** High frequency, high structure **d.** Low frequency, low structure **e.** Low frequency, high structure	Self-report journals	Results showed significantly more walking for prompts versus no prompts and high frequency prompts versus low frequency prompts; no effect was observed for prompt structure
Kriska 1986	US Women, postmenopausal, 50–65 y/o, healthy	229	**a.** Walking groups 2x/week for 8 weeks; continued walking with group or on own for 2 years; face-to-face counseling; telephone prompts; monthly newsletters **b.** No-treatment	Self-report journals	Group *a* increased their walking at years 1 and 2 relative to group *b*; Group *b* did not increase walking

* This study is a follow-up of Kriska et al., 1986.