September 2010 – Knowledge to Action Evidence Summary

What evidence exists to describe the effect of interventions that use pedometers to reduce risk for and manage chronic disease?

This report aims to summarize the evidence around pedometer-based interventions designed to increase levels of physical activity among those at risk for and/or suffering from chronic disease. Its intention is to support efforts that seek to increase levels of physical activity for those with chronic disease in the Champlain region of the province of Ontario, Canada.

Key Messages

- It is generally recognized that physical activity can contribute to the prevention and management of multiple chronic illnesses.
- Physical inactivity among those at risk for or suffering from chronic disease is estimated to cost health systems billions of dollars annually and is linked to mortality.[1]
- Pedometers have recently gained recognition as a useful intervention in the promotion of physical activity.
- The size and type of effect of using pedometer-based interventions on risk factors for and health outcomes in chronic disease is not yet well-understood.
- Implementation of pedometer-based physical activity programs is challenging, particularly in those at risk for or suffering from chronic disease
- Multi-faceted interventions (e.g. pedometers used in conjunction with counseling and/or goal-setting) and those of longer duration appear to have a greater and more positive effect than pedometers alone.[2]

Who is this summary for?

This summary was undertaken as part of the CIHR-funded, OHRI-Champlain LHIN Knowledge to Action collaborative research program and is intended for use by health systems stakeholders, policy- and decision-makers. Information on the research program can be located at www.ohri.ca/kta

Information about this evidence summary.

This report covers a broad collection of literature and evidence sources with a **search emphasis** on systematic reviews.

As such, evidence summarized from systematic reviews is highlighted in blue boxes, like this one. Systematic reviews are generally favoured over other study designs, because they incorporate evidence from multiple primary studies, instead of reporting evidence from just one study.

☑ This summary includes:

- **Key findings** from a broad collection of recent published literature and evidence sources.

☒ It does not include:

- **Recommendations**;
- **Additional information** not presented in the literature;
- **Detailed descriptions of the interventions** in the studies.

All papers summarized in this document are available by request to kkonnyu@ohri.ca.

Some sections conclude with a "Bottom line" subsection that provides a statement summarizing the studies included in this document or aims to provide some context; these statements are not meant to address all of the evidence in existence on the subject, rather, that which is featured in this document.

Background

Despite a wealth of evidence supporting physical activity for the prevention and management of dozens of chronic illnesses[3], most Canadians do not take part in recommended levels of exercise.[4]

Multiple approaches to increasing levels of physical activity have been undertaken; pedometers have been used in numerous research interventions aimed at increasing levels of physical activity. While most of these studies report moderate success by achieving short-term improvements, longer-term gains in physical activity levels and various health outcomes are understudied and elusive.

This evidence summary aims to advance the understanding of available evidence on the effect of interventions employing pedometers in those at risk of or suffering from chronic disease by summarizing the literature in this area.

Levels of Evidence (adapted from Cochrane MSK group[5])

Each piece of evidence presented in this summary is assigned a level. This assignment is based on the piece of evidence being presented, NOT necessarily on the study from which it is taken (e.g. RCTs often report baseline → post-intervention results per group; this evidence is assigned a "Silver" rating because it reports within-group changes, not between-group changes).

Platinum: Systematic reviews and meta-analyses.

Gold: Randomized controlled trials.

Silver: Observational studies (non-randomized trials, case-control, time-series, cohort studies, case series, literature reviews).

Bronze: Expert committee guidelines, reports or opinions and/or clinical experience of respected authorities (e.g. commentary, editorial).

Level of evidence cannot be determined.

Contents

Summary of Findings

Overview of the evidence on pedometers and chronic disease

- Many sources can be found advocating the use of pedometers[6 7 8] to increase physical activity in various patient populations; yet, evidence remains limited and is largely derived from small cohort studies of brief duration and anecdotal "evidence" underscoring their value. Nonetheless, enthusiasm for this technology as a mechanism for motivating physical activity is growing rapidly among the clinical community as evidence favouring pedometers continues to emerge.

- A 2009 systematic review examined studies measuring free-living steps/day in those with chronic illness to facilitate planning and physical activity programs; findings show that "…the lowest median values for steps/day are found in disabled older adults (1214 steps/day) followed by people living with COPD (2237 steps/day). The highest values were seen in individuals with Type 1 diabetes (8008 steps/day), mental retardation/intellectual disability (7787 steps/ day), and HIV (7545 steps/day)."; authors conclude "It is important to emphasize here that expected values convey estimates of central tendency and variability for habitual steps/day derived from a review of published literature. Their use does not imply any association with what people with such diseases or disabilities 'should' be taking..."[9]

- A 2006 effectiveness review and public health guidance report by the National Institute for Health and Clinical Excellence (NICE) addresses the use of pedometers in public health; the Institute concludes that "[The Public Health Interventions Advisory Committee] determined that there was insufficient evidence to recommend the use of pedometers and walking and cycling schemes to promote physical activity other than as part of research studies where their effectiveness can be evaluated."[10]

- A 2007 U.S. systematic review and meta-analysis examined the effect of pedometers on physical activity and various health measures in adult outpatients; analysis of 26 studies found a significant improvement in levels of physical activity ($p<0.001$), BMI ($p=0.03$) and systolic blood pressure ($p<0.001$); authors note that while the long-term effects of pedometers are less-well understood, they conclude that "the use of a pedometer is associated with significant increases in physical activity and significant decreases in body mass index and blood pressure."[11]

- A 2007 Canadian survey of the general population examined whether the source of pedometer ownership was associated with physical activity levels; results from 211 pedometer owners found that approximately one-third each reported having obtained their pedometer by purchasing it, as a gift or as a promotional giveaway (respectively); authors conclude that "… although pedometer ownership may be related to self-efficacy and outcome expectations in relation to [leisure-time physical activity] (LTPA), it is not directly associated with higher LTPA levels or walking… Health promoters considering using pedometers should investigate ways to maintain the motivational and behavioral effectiveness of pedometers."[12]

Bottom Line:

- There are multiple, complex factors in determining the effect, impact and role of pedometers for increasing physical activity with a goal of reducing risk for and managing chronic disease;
- The direction of evidence to-date seems to support the assertion that pedometers have a positive effect on a variety of health measures and outcomes;
- However, the size of that effect is less certain, appears to be modest and requires further empirical investigation.

Condition-specific evidence for pedometer-based interventions in those <u>suffering from</u> chronic disease

Asthma

- A 2009 U.S. case-control study examined the effect of a pedometer-based exercise intervention in children and youth with and without asthma; while no between group differences were found, both groups (combined and independently) significantly increased their levels of physical activity (steps/day; $p<0.0001$); authors conclude that "…we documented statistically significant increases in physical activity across both groups following a brief, pedometer-based intervention."[13]

Cancer

- A 2009 U.S. RCT examined the effect of a pedometer-based exercise intervention vs. bisphosphonates on bone density levels in breast cancer patients receiving chemotherapy; while the primary outcome measure showed that bisphosphonates were more effective in preventing bone loss than physical activity, secondary results reported that the pedometer-based intervention group significantly increased their levels of physical activity over time compared with the bisphosphonates-only group, suggesting that a pedometer-based intervention may be effective for increasing physical activity among breast cancer patients.[14]

- A 2007 Canadian RCT examining long-term physical activity in 377 breast cancer survivors used pedometers in 2 of its 4 arms; no significant improvements in self-reported physical activity, fatigue nor health-related quality of life measures were found among 277 patients at 6-months follow up; authors note that qualitative analysis indicated patients found the pedometers to be motivating, encouraging and appreciated the feedback it gave on their physical activity; authors conclude that while no statistically significant improvements could be attributed to the pedometer groups, trends for increased physical activity were noted.[15]

Cardiovascular Disease (CVD)

- A 2009 Australian study randomized 122 cardiac rehab patients to a pedometer-based exercise intervention or control group; results for 110 patients at 6 months showed significantly increased levels of self-reported physical activity ($p<0.05$), corroborated by indices of cardiorespiratory fitness ($p=0.01$); authors conclude that this pedometer-based intervention was successful in maintaining physical activity in patients following a cardiac rehab program.[16]

- A 2008 U.S. study randomized 553 hypertensive workers to a workplace walking intervention w/pedometer v. a minimally intensive intervention (controls; no pedometers); results for 141 participants at 1 year follow up showed significant improvements in BMI ($p<0.01$) and systolic BP ($p=0.04$) among the pedometer group compared with controls; authors conclude that "A targeted worksite intervention program may be an effective way to lower BP and promote exercise and weight loss."[17]

- In a 2009 commentary and review of the literature on "How to Avoid a Heart Attack", Dr. Thomas Haffey of the American College of Cardiology Colorado advocates for prescription of pedometers to patients with CVD risk factors, based on the American Heart Association's recommendations for the accumulation of daily exercise in this risk group.[18]

- A 2007 U.S. study examined adverse events in an RCT of walking interventions (pedometer-based and control) among men at high risk for cardiovascular events; results from 274 men at 18 months showed 121 adverse events among 87 individuals; authors conclude that "Men at high risk for adverse cardiovascular events can safely be advised to start a progressive walking program. Results suggest that minor to serious medical problems unrelated to exercise are a major barrier to walking adherence. Helping individuals with chronic illness return to physical activity quickly but safely after an adverse event is an important component of any physical activity intervention targeting this population."[19]

Chronic disease (generally)

- A 2010 U.S. study randomized 18 chronic disease patients to wear either a pedometer or accelerometer to measure steps/day or moderate-vigorous physical activity (MVPA); results for 18 patients at 4 weeks showed a significant increase in steps/day for both groups and a significant increase in MVPA in the accelerometer group only; authors conclude: "Data suggest that individuals with chronic disease conditions can more effectively increase levels of physical activity, expressed as both MVPA/day and steps/day, by self-monitoring [MVPA] rather than [steps/day]."[20]

Chronic Obstructive Pulmonary Disease (COPD)

- A 2009 commentary questions the validity of pedometers for measurement of physical activity in patients with COPD; the author summarizes a study that finds pedometers can produce invalid results in COPD patients that walk at a slower pace than can be measured accurately; the author concludes that "… currently it is not advisable to use pedometers to measure activity in COPD patients and in particular to assess a specific intervention such as pulmonary rehabilitation."[21]

- Another commentary from 2006 counters the previous assertion by recognizing the concerns around using pedometers with COPD patients but point out that, when used specifically to measure intentional activity vs. free-living activity, pedometers can be a useful and valid tool.[22]

- A 2010 U.S. study randomized 17 post-rehab COPD patients to a pedometer-based physical activity intervention with or without weekly cell phone text coaching; results showed the group without cell phone text coaching significantly (p=0.04) increased their steps/day; authors conclude that while delivery of this type of intervention is feasible, the personal coaching component did not improve the results.[23]

- A 2009 Dutch study randomized 35 COPD outpatients to a 12-week pedometer-based exercise counseling intervention or usual care; results from 35 patients showed a significant increase in walking activity, strength measures and motivation to be active among intervention participants compared with controls; authors conclude that this type of intervention is feasible and effective in COPD outpatients.[24]

- A 2006 Dutch study randomized 21 patients with COPD to a 9-week rehabilitation program with or without an added lifestyle program including pedometers; results from 16 patients showed that while both groups increased their levels of physical activity, the difference between groups was not statistically significant; authors conclude that "The additional lifestyle physical activity counseling program with feedback of a pedometer showed a clinically relevant increase in steps/day, although not statistically significant…"[25]

- A 2000 Spanish study randomized COPD patients to a supervised (no pedometer) vs. self-monitored (w/pedometer) walking program; results for 41 patients at 8 weeks showed improvements in physical activity for both groups over baseline, with more significant improvements in the supervised group; authors conclude that "Both types of training improved exercise tolerance, but the magnitude and the extent of physiological improvements were larger in patients training under supervision."[26]

Depression

- A 2008 U.S. cohort study examined the effects of a multi-faceted intervention, including physical activity promotion with pedometers, for depressed patients; results from 23 patients at 12 weeks showed significant improvement in daily step counts (p=0.03), depressive symptom and QOL scores (p<0.001); authors conclude that "…participants are willing to participate in a multi-component 12-week intervention delivered mostly by the web and telephone. Depressive symptoms, quality of life and step counts improved over the 12 weeks of the study."[27]

Diabetes

- A 2010 U.S. study randomized 53 type 2 diabetes mellitus (T2DM) patients to a self-management program with or without a pedometer; results from 33 participants show that while both groups significantly decreased A1C levels and weight, only the pedometer group decreased diastolic blood pressure; authors conclude that while pedometers are a helpful intervention for motivating type 2 diabetics to become more active, a simple self-management program without pedometers is also an effective strategy.[28]

- A 2010 Indian study randomized 40 patients with T2DM to a pedometer-based intervention vs. controls (usual care); results from 40 patients at 8 weeks showed significant improvements in HbA1C, FBG, blood pressure and general well being ($p<0.05$); authors conclude that "Our study showed that monitoring an aerobic walking program using a pedometer and HRM is effective in changing the studied parameters of glycemic control, cardiovascular indices and [general well being]."[29]

- A 2008 Norwegian systematic review of studies examining the effect of pedometers on type 2 diabetics or those who were overweight and/or inactive found that most studies do not investigate pedometers alone, making it difficult to associate outcomes to pedometers; analysis of 4 relevant studies reported that findings are either uncertain due to short duration of study or show no effect over the long-term; authors conclude that pedometers have thus far failed to show an effect on physical activity in those who are overweight, inactive or have T2DM.[30]

- A 2010 Finnish study examined the pedometer-based component of a group-counseling intervention to increase physical activity for 74 patients at high risk of T2DM; results showed a significant increase in physical activity among those using the pedometer regularly; qualitative analysis indicated that perceived benefits of the pedometers included continual feedback on patients' activity levels and the ability to set specific activity goals while barriers to pedometer use included inability to manage the technicality of the pedometers and the inability of the pedometers to measure activity other than walking.[31]

- A 2009 New Zealand study randomized 78 type 1 diabetic adolescents into a study examining whether pedometers and text messaging could increase physical activity levels; results at 12 weeks showed no improvement in levels of activity leading authors to conclude that while the study was small and underpowered, adherence to pedometer use among this population was low.[32]

- A 2009 Canadian study randomized 41 T2DM patients to either a minimally intensive or more aggressive healthy lifestyle intervention, both employing pedometers and goal-setting; results for 37 subjects at 24 weeks showed significant improvements in weight, BMI and blood pressure ($p<0.001$) from baseline for both groups (no between-group difference on these outcomes), suggesting that even a minimally intensive pedometer-based intervention can have a positive effect on increasing physical activity in patients with T2DM.[33]

- A 2008 Norwegian study randomized 70 T2DM patients to an exercise counseling intervention with or without pedometers; results from 48 patients at 6 months showed that while significant benefits were achieved for all patients in the study from baseline, there was no significant benefit achieved among those in the pedometer intervention group over the non-pedometer group; authors conclude that "the use of pedometer did not increase walking or enhance beneficial metabolic outcomes."[34]

- A 2008 Polish study randomized T2DM patients to a pedometer + advice intervention vs. advice-only to increase physical activity; results for 30 patients at 5 weeks showed that the pedometer group significantly improved rates of physical activity from baseline where as the control group did not; authors conclude that "Oral advice has small effect on time spent on walking among patients with type 2 diabetes. Providing a pedometer with internal memory makes such advice more effective."[35]

- A 2008 Australian study examined a 2-week advice-only vs. pedometer-enhanced intervention in patients with T2DM or impaired glucose tolerance (IGT); while results showed significant improvements in intervention participants compared with controls, 20-week follow up showed no difference; authors conclude that a brief pedometer-based intervention has short-term benefits but more research is needed into making long-term gains.[36]

- A 2007 U.S. RCT compared a pedometer-based physical activity intervention with goal-setting vs. standard educational materials in 28 African-Americans and Hispanics aged 55+ with T2DM; results at 6 months showed the intervention group increased their caloric output by more that twice as much as controls and their moderate-intense physical activity by more than eight times; authors conclude that "Giving older type 2 diabetic patients a pedometer and a goal to meet may be enough to get them moving."[37]

- A 2007 U.S. study randomized 35 T2DM patients to 2 pedometer interventions that used either lifestyle (steps/day) or structured (duration and intensity) goal-setting to increase the intensity of physical activity; results from 30 patients at 6 weeks showed that both groups improved with no difference between groups other than the pedometer group demonstrated greater satisfaction with the intervention; authors conclude that "Pedometer-based walking programs that emphasize total accumulated step counts are more acceptable to participants and are as effective at increasing moderate intensity bouts of physical activity as programs that use structured goals."[38]

- A 2006 U.S. study randomized patients with T2DM to a pedometer-based intervention or control; results at 6 weeks showed a significant improvement in physical activity (steps/day) among the pedometer group vs. controls ($p=0.02$); authors conclude that "…use of a pedometer may prove to be an effective tool for promoting healthy lifestyle changes…"[39]

- A 2006 Australian study randomized 54 overweight/obese T2DM patients to a physical activity coaching intervention with or without a pedometer; results from 50 patients at 6 months showed that both groups significantly improved their weight, cardiovascular fitness and waist circumference, but no statistically significant differences were found between groups on any measure; authors conclude that a coaching intervention can improve physical activity for T2DM patients, but that "…using a pedometer added no further benefit."[40]

- A 2006 Canadian cohort study examined the use of pedometers and stopwatches to increase the intensity of physical activity in a group of T2DM patients after participation in an RCT examining a pedometer-based intervention; results at 12 weeks from 11 patients showed significant improvements in cardio-respiratory fitness; authors conclude that "The [intervention]… elicited significant improvements in cardiorespiratory fitness over 12 weeks in a group already walking >10,000 steps/day."[41]

- A 2005 Canadian RCT compared the First Step Program, an intervention designed to increase physical activity in sedentary individuals with T2DM using goal-setting and pedometers against controls (usual care); results from 38 participants at 24 weeks follow up showed significantly improved levels of physical activity ($p<0.0001$) in the intervention group vs. controls; authors conclude that, while no other significant changes were found between groups, the intervention constitutes an important first step toward increasing physical activity among T2DM patients.[42]

- A 2005 Canadian cohort study of 19 T2DM patients who had just completed the First Step Program, a pedometer-based intervention designed to increase physical activity, measured walking speed/intensity in this population; results showed that the cohort was not meeting a walking speed associated with a moderate-level of activity; authors conclude that "… participants may benefit from additional conditioning to manage the demands of increased walking speeds", and suggest the possibility of using enhanced interventions that use devices measuring and providing feedback on the participants' intensity of exercise.[43]

- A 2006 cohort study reports positive results from a population-based pedometer intervention study, suggests these results may be useful in those at risk for developing and with T2DM and offers several suggestions for development of interventions, including:
  - Make it fun;
  - Minimize response effort;
  - Make it interactive;
  - Provide incentives;
  - Collect data on more than just steps;
  - Keep outcome expectations realistic.[44]

Kidney disease

- A 2010 Polish study investigated whether carrying a pedometer and recording daily readings would increase spontaneous walking activity in 33 chronic hemodialysis patients; results showed a significant increase in the number of steps taken by patients, both on dialysis days ($p=0.0005$) and non-dialysis days ($p=0.001$) leading authors to conclude that pedometers can increase physical activity in those undergoing chronic hemodialysis.[45]

Neuromuscular/Musculoskeletal

- A 2007 U.S. study compared a physical activity promotion program with pedometers vs. an education program in patients diagnosed with fibromyalgia syndrome (FMS); results for the pedometers group (n=14) at 12 weeks showed a significant increase in steps/day; no between group differences were found for pain, fatigue, FMS impact nor 6-min walk distance; authors conclude that "… a 12-week program designed to help previously sedentary persons with FMS accumulate at least 30 minutes of self-selected moderately intense physical activity throughout the normal course of the day increased their physical activity, as assessed by pedometer, by 70 percent."[46]

- A 2003 U.S. study randomized 40 elderly knee osteoarthritis patients to a home-based, self-management program with or without goal-setting + pedometers; results from 34 patients at 24 weeks showed improved physical activity (steps/day), muscle strength and agility in the pedometers group; authors conclude that "…in older adults with symptomatic knee OA, [the pedometer-based intervention] resulted in more walking."[47]

Condition-specific evidence for pedometer-based interventions in those with <u>risk factors</u> for developing chronic disease

CVD Risk Factors

- A 2007 U.S. study randomized individuals with CVD risk factors to one of two pedometer-based interventions; results at 10 weeks from 14 participants showed that both groups significantly ($p<0.05$) increased steps/day from baseline but no between-group nor other significant changes were found in primary outcomes of interest; authors conclude that "Both programs were equally effective in increasing physical activity over 10 weeks. Increases in physical activity resulted in improved fitness and blood glucose but were not sufficient to provide changes in multiple heart disease risk factors or inflammation."[48]

- A 2006 review of the literature examining the effect of walking programs on CVD risk in women concludes, with regard to pedometers: "Pedometer-monitored walking has been found to be effective in improving CVD risk factors in women. Using a pedometer and a set step goal is of great interest, as this method of exercise prescription does not involve an intensity recommendation and relies solely on increasing overall daily walking. The use of pedometer-monitored walking may also lead to better adherence in women because of the less regimented exercise routine, allowing them to fit it into their daily lifestyle however they choose."[49]

- A 2005 U.S. cohort study examined a nutritional intervention enhanced by pedometers for patients with CVD risk factors; results from 12 patients at 3 weeks showed significant weight loss ($p=0.004$) and increase in steps/day ($p=0.04$); authors conclude that "Enhanced pedometer feedback in conjunction with nutritional counseling is feasible and results in significant weight loss and increased walking among individuals at high risk for cardiovascular disease."[50]

Elderly

- A 2007 U.S. RCT randomized 179 older adults to a pedometer intervention or usual care; results at 12 weeks showed a significant increase in steps/day for the pedometer group compared to controls and at 24 weeks a significant increase in steps/day for both groups over baseline; authors conclude "The pedometer-based intervention was effective in increasing participants' daily step counts."[51]

- A 2008 U.S. cohort study of 592 older adults in senior centers examined the effects of a community-based intervention including physical activity promotion with pedometers; results from 418 seniors at 4 months follow up showed significant improvements in physical function and levels of physical activity ($p<0.001$); authors conclude that the intervention "… was associated with significant improvements in objective measures of physical performance and self-reported minutes of daily physical activity and step counts, as well as decreases in some barriers to physical activity."[52]

- A 2006 U.S. study randomized older patients (most with ≥1 chronic disease) to a pedometer-based intervention vs. controls (usual care); results from 147 patients at 12 weeks showed significant increases in physical activity levels among the pedometers group and qualitative analysis indicated patients showed enthusiasm for the pedometers as a means of motivating physical activity; authors conclude that "A pedometer-based intervention has the potential to positively influence the physical activity levels of older adults, most of whom had one or more chronic illnesses."[53]

Overweight/Obese

- A 2009 UK study randomized 123 overweight/obese primary care patients to nurse-led structured support or usual care interventions with or without pedometers; results from 103 patients indicate that the structured support component had a greater effect on weight loss and waist circumference than the pedometer component; authors conclude that structured support intervention is feasible and practical in overweight/obese primary care patients.[54]

- A 2009 Australian study randomized 30 overweight/obese women to a pedometer-based intervention or control group; results from 26 participants show that the pedometer group significantly ($p=0.03$) increased steps/day and decreased systolic blood pressure, however, no differences were found between groups in weight or body fat; authors conclude that pedometers are effective for increasing physical activity levels in overweight/obese women.[55]

- A 2009 Swedish RCT compared a minimally intensive vs. a more aggressive intervention, both employing pedometers for the purpose of motivating increased walking in abdominally obese women; results at 18 months showed significantly increased levels of physical activity (steps/day $p<0.001$) from baseline for both groups with no between-group difference, suggesting that even a minimally intensive pedometer-based intervention can have a positive effect on increasing physical activity in obese participants.[56]

- A 2008 U.S. systematic review and meta-analysis examined the effect of pedometers alone on weight change in overweight/obese subjects; analysis of 9 studies found that most studies (5/9) reported a significant amount of weight lost over time periods ranging from 8 weeks to 1 year; longer interventions were significantly associated with more weight lost; authors conclude that "Pedometer-based walking programs result in a modest amount of weight loss. Longer programs lead to more weight loss than shorter programs."[57]

- A 2006 U.S. cohort study examined the effect of a 36 week exercise prescription program with pedometers on 38 overweight/obese participants; analyses on those who adhered to the program (n=19) vs. those who did not (n=19) showed significant improvements in anthropometric measures; authors conclude that "Although both adherers and nonadherers significantly increased daily walking… only the adherers showed significant improvements in body weight, BMI, percentage body fat, fat mass, waist circumference, and hip circumference at 36 weeks."[58]

- A 2007 U.S. cohort study examined the use of pedometers to increase physical activity in obese, low-income women; self-reported results from 33 women at 12 months showed a trend toward increased number of steps/day, improved gait and lower extremity function and lowered BMI, but these improvements were not statistically significant.[59]

- A 2004 U.S. cohort study examined a weight-loss intervention for elderly, obese women employing (among other things) use of a pedometer and daily step goal; results from 18 participants at 3 months showed significant increases in physical activity from baseline (steps/day; p=0.006); authors also report "Significant improvements were observed for diastolic blood pressure, total cholesterol, triglycerides, physical performance, pedometer-measured step counts, and step climb and descent. Self-rated physical functioning (SF-36 subscore) and vitality (SF-36 subscore) were also significantly improved."[60]

- A 2000 U.S. study randomized 34 obese children to one of two contingency interventions requiring children to earn video game and/or television activity by accumulating pedometer steps vs. a non-contingency group; results showed that children in the contingency groups accumulated significantly more steps and greater intensity than controls; authors conclude that "…contingent access to sedentary activities can reinforce physical activity in obese children…"[61]

Prediabetes/IGT/IFG

- A 2009 UK study randomized 98 patients with impaired glucose tolerance (IGT) to a group-based education program with or without pedometers against controls; results from 87 participants at 12 months showed that glucose levels were significantly decreased in the pedometer group vs. controls and that activity levels were higher in both intervention groups vs. controls; authors conclude that this type of pedometer-based intervention is effective in improving glucose tolerance in those with IGT.[62]

- A 2005 U.S. cohort study of 20 patients with neuromuscular disability (NMD) and risk factors for metabolic syndrome examined a home-based intervention employing pedometers and goal setting (steps/day); results at 6 months for 20 participants showed a significant increase in steps/day (p=0.001), reduction in percentage body fat and caloric intake, though no significant changes in metabolic syndrome risk variables were found; results at 12 months follow up indicated no statistically significant changes over baseline; authors conclude that "In this population of disabled people with NMD, we found that the combination of a modest activity prescription and dietary intervention produced modest improvements in physical activity, caloric intake, and body fat percentage. However, components associated with metabolic syndrome were not affected."[63]

- A 2003 U.S. cohort study of 18 overweight/obese women with T2DM risk factors examined the effect of a walking intervention, using pedometers and goal-setting, on glucose tolerance; results at 12 weeks showed a significant improvement in glucose tolerance ($p<0.001$) and blood pressure ($p<0.001$), however no change in body mass/fat and waist circumference were achieved; authors conclude that a walking program using goal-setting and pedometers may still benefit those at risk for T2DM without reducing weight.[64]

Sedentary

- A 2009 Scottish study randomized self-reported sedentary participants to a pedometer-based walking program with goal setting vs. controls (usual activity) to examine impact on markers of insulin resistance and systemic inflammation; results from 48 participants at 12 weeks showed significant increases in physical activity from baseline for the intervention group with no changes in any other outcome measures; authors conclude that "… the current community-based intervention did not affect systemic markers of inflammation or insulin sensitivity."[65]

- A 2008 RCT examined the effect of telephone-delivered motivational interviewing (MI) plus pedometers vs. phone calls alone (no MI; no pedometers) among sedentary rural adults; results showed no increase in self-reported physical activity but a significant increase in self-efficacy for exercise; authors conclude that "The intervention increased self-efficacy for exercise but did not increase physical activity…"[66]

- A 2005 U.S. study examined pedometer-monitored walking recommendations to accumulate 10,000 steps/day (unsealed pedometer) vs. a brisk, 30-min walk most days/week (sealed pedometer) in sedentary women; results from 58 women at 4 weeks showed significantly more steps/day among the 10,000 steps/day group ($p<0.005$); authors conclude that "Women walk more when told to take 10,000 steps per day compared with those instructed to take a brisk 30-min walk. On days when women took a 30-min walk, their average step count was near 10,000."[67]

- A 2007 Australian trial randomized 369 sedentary adults to a walking program with or without pedometer vs. controls (no treatment); results at 3 months for 314 participants showed significant increases in self-reported physical activity levels for both intervention groups from baseline, but no statistically significant differences between intervention arms, casting doubt on the added value of pedometers over a structured walking program alone for increasing physical activity among sedentary adults.[68 69]

- A 2007 U.S. RCT compared two e-mail-delivered, pedometer-based interventions (with and without transtheoretical model concepts incorporated) in inactive women aged 25-54; results from 56 women in both groups at 6 weeks showed significant increases in time spent walking ($p=0.002$) from baseline; no significant differences between groups were reported; authors conclude that "…email-delivered, pedometer-based interventions may impact walking… among insufficiently active women… this low-cost method of intervening may be an effective approach to combat physical inactivity in women."[70]

- A 2007 U.S. cohort study examined a physical activity intervention for rural women delivered through primary care and using a combination of counseling, pedometer and videotape; results for 60 patients at 6 months showed a significant increase in steps/day ($p<0.001$); authors conclude that "a brief intervention based within a primary care setting can achieve short-term increases in physical activity in rural women."[71]

Bottom Line

- While most studies examining the effect of interventions with pedometers in those with chronic disease show at least some positive effect, a considerable number of others show little to no effect;
- Intervention research on pedometers to-date is plagued by short duration of study follow up and small sample sizes;
- Pedometers are often one component of a multi-faceted intervention, making their independent effect difficult or impossible to isolate;
- Qualitative analyses that consider barriers and facilitators to pedometer use may be of benefit in making determinations about their perceived usefulness to increasing physical activity in various chronic disease populations.

Studies and trials underway/ongoing examining pedometers in those at risk for or suffering from chronic disease

Alzheimer's

- A U.S. RCT is comparing 4 physical activity interventions (2/4 w/pedometers) designed to reduce sleep disturbances in patients with Alzheimer's disease; estimated enrolment is 136 patients and study results are expected in October 2010.[72]

Cancer

- A Canadian RCT is examining use of a pedometer-based physical activity intervention in men treated for prostate cancer with hormone therapy to determine whether treatment side effects are reduced by exercise; expected enrolment is 400 patients and projected completion is September 2011.[73]
- A U.S. cohort study is currently examining the effect of a pedometer-based intervention on severity of fatigue in cancer patients undergoing chemotherapy.[74]
- A U.S. RCT is comparing two physical activity interventions, with and without pedometers for their effect in preventing breast cancer in women at risk of developing the disease; targeted enrolment is 175 and follow up at 3 months will measure change in physical activity level as steps/day.[75]
- A U.S. RCT is comparing a motivational interviewing intervention against an active comparator intervention including pedometers for their effect on physical activity levels in women undergoing breast cancer treatment; targeted enrolment is 40 participants and the 1-year follow up will measure changes in body weight and percent body fat.[76]
- A Canadian RCT is examining the effect of a physical activity intervention with pedometers against minimal intervention (leaflet) in breast cancer treatment patients; targeted enrolment is 290 patients and follow up at 6 months will measure self-reported physical activity levels.[77]
- A U.S. RCT is comparing a physical activity intervention with pedometers vs. a relaxation therapy intervention in patients with stage IV or recurrent, inoperable colon cancer patients; expected enrolment is 150 patients and follow up at 16 weeks will primarily measure program recruitment, retention, adherence and physical function.[78]

CVD

- An Australian cluster RCT is comparing resilience training interventions with or without a physical activity promotion component (including pedometer), against controls in patients with coronary heart disease; authors aim to recruit 95 patients.[79]
- An Australian RCT is comparing a multi-faceted, telephone-delivered intervention against a control intervention (both w/pedometers) in cardiac rehabilitation patients in both urban and rural settings; the 8 week intervention will be assessed at 8 weeks and 8 months for anthropometric, physical activity and cost effectiveness measures.[80]

- A U.K. RCT study is examining the effect of a home-based walking intervention with pedometers and goal-setting on cardiac rehabilitation patients; 432 patients have been enrolled and follow up will measure quality of life indicators.[81]

- A Canadian RCT is examining the effect of a pedometer-only intervention on walking activity in cardiac rehabilitation patients; targeted enrolment is 225 patients and authors hypothesize that pedometers, in the absence of some other conditional factor, will not increase physical activity levels.[82]

COPD

- A U.K. RCT is comparing a Health Enhancing Physical Activity (HEPA) program with pedometers against usual care in patients with COPD; enrolment is expected to be 100 patients and follow up at 1 year will examine exercise capacity and disease progression.[83]

- A U.S. RCT is comparing a Web-based pedometer intervention designed to increase walking and improve function among veterans with COPD against controls; targeted enrolment is 300 patients and the primary outcome measure is self-reported respiratory-specific quality of life.[84]

Diabetes

- The ADAPT trial is a Canadian RCT examining 3 walking interventions (less intense → most intense; 2/3 arms w/pedometers) in patients with T2DM; 287 patients have been randomized and follow up at 3, 6, 9, 12 and 18 months is planned.[85]

- A U.S. RCT is comparing a Web-based, pedometer intervention vs. usual care to reduce the risk of T2DM in women with history of gestational diabetes mellitus (GDM); estimated enrolment is 60 women with a projected completion of April 2011.[86]

- A Chinese RCT is examining the effect of a home-monitoring intervention, including pedometers, for hypertensive patients with T2DM; targeted enrolment is 100 patients and follow up at 6 months will examine anthropometric and blood pressure measures.[87]

- A U.K. RCT is examining the effect of a physical activity promotion intervention with and without pedometers in patients with IGT; enrolment has reached 103 patients and the primary outcome measure is 2-hour glucose.[88]

- A Belgian RCT is comparing the effect of a pedometer-based intervention vs. usual care in T2DM patients; expected enrolment is 92 patients and follow up at 6 and 12 months will examine physical activity levels, anthropometric and blood glucose measures.[89]

Kidney disease

- A Canadian RCT is comparing the effect of ergometer- vs. pedometer-based interventions, in patients undergoing outpatient hemodialysis; expected enrolment is 60 patients and follow up at 3 and 6 months will measure physical function, aerobic capacity, quality of life and dialysis adequacy.[90]

Overweight/Obese

- A U.S. RCT is comparing two pedometer-based interventions with fixed or adaptive goal setting in overweight/obese black women; targeted enrolment is 226 participants and follow up at 24 weeks will measure adherence, physical activity level and change in BMI.[91]

Sedentary

- A New Zealand RCT is comparing primary care-based physical activity interventions with or without pedometers for sedentary patients >65yrs old; follow up on 270 patients at 12 months will be reported on in the near future.[92]

- A U.S. RCT is comparing an exercise therapy intervention including pedometers to usual care in older patients with abdominal aortic aneurism; targeted enrolment is 340 patients and follow up at 3 years will measure disease progression.[93]

Vascular

- A U.K. crossover RCT is examining exercise programs with or without pedometers on levels of physical activity in patients with peripheral vascular disease; targeted enrolment is 60 patients.[94]

Resources of Potential Interest

The following may be of interest and/or use in considering the development and implementation of pedometer-based programs for increasing physical activity in chronic disease populations.

Table 1. Pedometer Comparison List

Pedometer; contact	Mechanism	Cost	Accuracy
Freestyle Pacer Pro www.fsfitness.com	Metal-Metal	US $20	Moderately accurate*
Kenz Lifecorder	Piezoelectric Crystal	$200	Most accurate
New Lifestyles NL-2000- www.new-lifestyles.com/	Piezoelectric Crystal	$50	Most accurate
Omron HJ-105 www.omronhealthcare.com	Magnetic Reed Proximity Switch	$27	Least accurate
Oregon Scientific PE316CA www2.oregonscientific.com	Magnetic Reed Proximity Switch	$20	Moderately accurate
Sportline 330 www.sportline.com	Metal-Metal	$13	Least accurate
Sportline 345 www.sportline.com	Metal-Metal	$30	Moderately accurate
Walk4Life LS 2525 www.walk4life.com	Metal-Metal	$29	Moderately accurate
Yamax Skeletone EM-180 www.new-lifestyles.com/	Magnetic Reed Proximity Switch	$15	Moderately accurate
Yamax Digi-Walker SW-701 www.new-lifestyles.com/	Metal-Metal	$30	Most accurate

*NOTE: Most = +/- 17 steps; Moderate = +/- 100 steps; Least = +/- 188 steps.

Source: Med Sci Sports Exerc. 2003;35(10):1779-1784.

Blatner DJ, Kushner RF. Pedometers: A tool you can use in your practice. Obes Manag Feb 2006; 37-38.

Additional Pedometer Programs and Resources

U.S. Department of Health and Human Services SmallStep
Website: www.smallstep.gov

This site offers a step tracker that allows users "to set physical activity goals, enter and save their physical activity on a calendar, track and view a graph of their progress, and earn an achievement certificate for reaching their goals."

Shape Up America Website
www.shapeup.org/10000steps.html

This website offers a program that encourages walking with pedometers.

The Step Diet
by James Hill and John Peters, with Bonnie Jortberg
Workman Publishing, 2004.

The Step Diet details how pedometers can help people lose weight.

Blatner DJ, Kushner RF. Pedometers: A tool you can use in your practice. Obes Manag Feb 2006; 37-38.

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Conflict of Interest
None declared

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