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How Many Steps/Day Are Enough?
Preliminary Pedometer Indices for Public Health

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Abstract

Pedometers are simple and inexpensive body-worn motion sensors that are readily being used by researchers and practitioners to assess and motivate physical activity behaviours. Pedometer-determined physical activity indices are needed to guide their efforts. Therefore, the purpose of this article is to review the rationale and evidence for general pedometer-based indices for research and practice purposes. Specifically, we evaluate popular recommendations for steps/day and attempt to translate existing physical activity guidelines into steps/day equivalents. Also, we appraise the fragmented evidence currently available from associations derived from cross-sectional studies and a limited number of interventions that have documented improvements (primarily in body composition and/or blood pressure) with increased steps/day.

A value of 10 000 steps/day is gaining popularity with the media and in practice and can be traced to Japanese walking clubs and a business slogan 30+ years ago. 10 000 steps/day appears to be a reasonable estimate of daily activity for apparently healthy adults and studies are emerging documenting the health benefits of attaining similar levels. Preliminary evidence suggests that a goal of 10 000 steps/day may not be sustainable for some groups, including older adults and those living with chronic diseases. Another concern about using 10 000 steps/day as a universal step goal is that it is probably too low for children, an important target population in the war against obesity.

Other approaches to pedometer-determined physical activity recommendations that are showing promise of health benefit and individual sustainability have been based on incremental improvements relative to baseline values. Based on currently available evidence, we propose the following preliminary indices be used to classify pedometer-determined physical activity in healthy adults: (i) <5000 steps/day may be used as a 'sedentary lifestyle index'; (ii) 5000–7499 steps/day is typical of daily activity excluding sports/exercise and might be considered 'low active'; (iii) 7500–9999 likely includes some volitional activities (and/or elevated occupational activity demands) and might be considered 'somewhat active'; and (iv) ≥10 000 steps/day indicates the point that should be used to classify individuals as 'active'. Individuals who take >12 500 steps/day are likely to be classified as 'highly active'.

Physical inactivity, or sedentarism,[1] is considered a major risk factor for a number of adverse health outcomes including obesity, hypertension, cardiovascular disease, diabetes mellitus and all-cause mortality.[2] Although national estimates of self-reported participation in leisure-time physical activity (derived from the 1998 Behavioral Risk Factor Surveillance System)[3] have remained relatively stable across recent decades, societal transitions in occupation, transportation, household management and non-sport/exercise leisure-time activities (e.g. increased television viewing) likely contribute to the obesity epidemic apparent in the US where the majority of the citizenry is either overweight or obese.[4] Unfortunately, such non-volitional and largely incidental activities are challenging to assess[1,5] and their relationship to weight maintenance and to overall health risk is only speculative at this time.

Public health recommendations[6] endorsed by the US Surgeon General[2] state that individuals accumulate 30 minutes of at least moderate-intensity activity (such as brisk walking) on a daily basis. This activity can be performed continuously or broken up into separate bouts throughout the day. This implies we need only track our time in at least moderate-intensity activity during the day and add up the separate bouts taken. On an individual level, timing and summing scattered bouts of activity requires constant attention that is impractical. Alternatively, motion sensors (e.g. accelerometers and pedometers) are unobtrusive body-worn instruments that detect movement taken throughout the day and can provide summary outputs.

Accelerometers portray movement as a volume of physical activity (e.g. activity counts) but they can also capture activity counts in very small units of time (e.g. 30 seconds, 1 minute) and can therefore be used to infer time spent in bouts of specific intensity categories (e.g. light, moderate, vigorous).[7,8] Accelerometers have become invaluable as activity assessment tools in research, notwithstanding their high cost ($US450+ [2003 values]), required supporting hardware and software, and relevant data management expertise.[1] Of the two motion sensors, however, pedometers are generally considered the more practical alternative for individual and population health promotion efforts.[1,7,9] They are simple to use, affordable ($US15–30), and the output (e.g. steps taken, steps/day) is extremely user-friendly.[1,10] In contrast to accelerometers, pedometers are not designed to distinguish physical activity intensity (an important independent contributor to health).[11] They do, however, detect steps taken (an indication of volume of physical activity) accurately.[12-14] Aggregated evidence of convergent validity (relative to other measures of physical activity)[15] and construct validity (relative to measures of health outcome) provides abundant support for using pedometers to assess physical activity.[15] One caveat is that pedometers are not sensitive to non-ambulatory activities (e.g. cycling, swimming, weight training), so the current discussion is necessarily limited to ambulatory activities.

Pedometers represent simple and affordable hardware, but without the software (e.g. guidelines, indices/cut points/benchmarks, programmes) their utility is limited. To optimise their value, researchers and practitioners require practical guidelines that include: (i) step indices associated with important health-related outcomes (e.g. obesity, hypertension) and/or health-related levels of physical activity (i.e. translations of public health recommendations); (ii) simple data collection quality control protocols; and (iii) feasible, acceptable and efficacious programme templates that can be adapted to multiple settings. These latter two points have been addressed elsewhere;[16,17] this commentary is focused on the appropriateness of step indices. The purpose of this commentary is to provide the rationale and evidence for general pedometer-based indices (relative to important health outcomes including obesity, hypertension, cardiovascular disease, diabetes, etc.) for public health research and practice purposes. In writing this piece, we referred to existing pedometer studies that have been compiled in tabular form previously[15,16] and also reviewed extensively in both and Bassett and Strath[18] and Tudor-Locke et al.[19]

1. How Many Steps Are Enough?

Physical activity guidelines have been traditionally formulated with expected benefits such as improved all-cause mortality[20] or prevention of weight gain[21] in mind. Presently, we lack direct evidence that accumulating any number of steps/day is associated with reductions in mortality. We are then left evaluating popular recommendations for steps/day, translating existing physical activity guidelines into steps/day equivalents, and appraising fragmented evidence from associations derived from cross-sectional studies and a limited number of interventions that have documented improvements (primarily in body composition and/or blood pressure) with increased steps/day.

In recent years, support for step indices based on pedometer-determined physical activity have surfaced either formally (i.e. through peer-reviewed literature) or more informally (i.e. through the lay literature). A value of 10 000 steps/day is gaining popularity with the media[22-25] and in practice.[26,27] Dr Yoshiro Hatano from the Kyushu University of Health and Welfare in Japan made a presentation at the annual meeting of the American College of Sports Medicine in 2001. He explained that the specific value has its roots in the popularity of Japanese walking clubs and a pedometer manufacturer (Yamasa Corporation, Tokyo, Japan) slogan from the 1960s. According to Dr Hatano, a pedometer came onto the Japanese commercial market in 1965 under the name of *manpo-kei* (literally translated, 'ten thousand steps meter').[28] The concept of achieving 10 000 steps/day remains widely familiar to Japanese households today. This level of steps/day is approximately equivalent to an energy expenditure of 300 and 400 kcal/day (depending on walking speed and body size).[28] In comparison, 30 minutes of moderate physical activity is approximately equal to an energy expenditure of 150 kcal.[2] The discrepancy between the two can be explained, in part, by the fact that the former is a daily recommendation that includes all activity, and the latter is a recommendation to be active 'over and above' an undisclosed minimal level of daily activity.

A value of 10 000 steps/day seems to be a reasonable estimate of daily activity for apparently healthy adults.[16] Welk et al.[29] reported that 73% of participants who recalled a minimum of 30 minutes of moderate activity on any specific day in the previous 7 days also achieved at least 10 000 steps on that same day. The participants in that study were younger (average age 29 years) and were recruited from a physical activity research centre, so we would expect higher values for steps/day. In comparison, Wilde et al.[30] reported that, even with a prescribed 30-minute walk, only 38–50% of women reached 10 000 steps on any single day. Nevertheless, the women increased their average physical activity from 7220–10 030 steps/day when they included a self-timed, 30-minute walk. This indicates a fair degree of similarity between the 10 000 steps/day recommendation and current US public health guidelines, if walking is the principal activity mode.

A recommendation to accumulate 10 000 steps throughout the day has many advantages. It is simple, easy to remember, and it provides people with a concrete goal for increasing activity. Moreover, as with any daily step goal, the recommendation is focused on behaviour (not the metabolic cost of that behaviour) and therefore applies to individuals of various body sizes.[28] In addition, there is growing evidence that 10 000 steps/day is an amount of physical activity that is associated with indicators of good health. For instance, individuals who accumulate at least this amount of activity have less body fat[28,31] and lower blood pressure[28] than their less active counterparts.

The study by Yamanouchi et al.[32] was the first to include a specific daily step goal. An exercise and diet group of individuals with type 2 diabetes mellitus lived at a hospital during the study and were told to take 10 000 steps/day. Over a 6–8 week period, they averaged >19 000 steps/day and lost an average of 7.7kg (almost 3.6kg more than a control group that dieted only and averaged approximately 4000 steps/day). Although the success of this programme in terms of goal attainment is impressive (in fact, the intervened patients far exceeded the set goal), it is not likely that this finding will translate

well to real-world situations. The patients in that study lived in a hospital protected from daily schedules and obligations, and likely had supportive and encouraging staff members who prompted regular walking bouts. Furthermore, although the authors reported a linear relationship between steps/day (r = 0.7257) and a measure of insulin sensitivity, it appears that no one took less than 10 000 steps/day. Overall, the impressive results must therefore be attributed to averaging 19 000 steps/day (not to 10 000 steps/day). Iwane et al.[33] reported that hypertensive individuals who averaged >13 000 steps/day for 12 weeks significantly reduced their blood pressure, providing support for taking >13 000 steps/day.

More recently, however, longitudinal studies of sedentary women have demonstrated health benefits of increasing to ≈10 000 steps/day. For example, a study by Moreau et al.[34] demonstrated that hypertensive women who increased to 9700 steps/day were able to reduce their systolic blood pressure (by 11mm Hg) and body mass (by 1.3kg) after 24 weeks of walking. Another study by Swartz and Thompson[35] examined the effects of a 10 000 steps/day intervention in overweight, sedentary women with a family history of type 2 diabetes. The women had significant improvements in glucose tolerance, despite no changes in body mass or percentage fat in this 8-week study. Other studies in progress will doubtless continue to inform our understanding of the efficacy and sustainability of a 10 000 step/day recommendation. Currently, a multi-strategy controlled intervention (the 10 000 Steps Rockhampton Project[36]) is being evaluated by researchers at the University of Queensland in Australia.

Sugiura et al.[37] reported the results of a 24-month study in which 32 women (aged 40–60 years) were asked to self-monitor their activity using a pedometer and increase their steps/day by at least 2000–3000 steps/day. Participants averaged ≈6500 steps/day at baseline, increased their physical activity to ≈9000 steps/day, and achieved significant improvements in lipid profiles, specifically improvements in total cholesterol, high density lipoprotein-cholesterol (HDL-C), and the total cholesterol/HDL-C ratio. Although the behavioural outcome of this study and that by Moreau et al.[34] approximated the 10 000 steps/day index, the focus on an incremental change (i.e in terms of steps/day and/or distance walked) in both studies makes this approach to physical activity recommendations somewhat different from previous ones.

Interventions have shown improvement in important health outcomes with an increment of 4300 steps/day over baseline[34] but also with as little as approximately 2500 steps/day over baseline.[37,38] In Canada, the First Step Program[10,17] advocates self-directed goal-setting (relevant to personal baseline values) and self-monitoring. This approach has generated immediate and profound improvements in physical activity behaviours.[38] Details of that programme are described in a recently published self-help book.[39] Another example is available through the Colorado on the Move campaign[27,40] that also encourages increased physical activity through pedometer self-monitoring. In their online literature, they state: If we can increase our physical activity by just 2000 steps a day, we can prevent weight gain among Coloradans and enjoy the many benefits of a more active and healthy lifestyle". These approaches to recommending incremental increases to usual daily activity (regardless of the actual magnitude of the increment) parallels that espoused by the US Surgeon General's public health recommendations. Unfortunately, we do not have a clear understanding of what is 'usual daily activity'.

2. What Steps/Day Are Indicative of Usual Daily Activity?

Aggregated reference values for steps/day indicate that healthy adults take between 7000–13 000 steps/day.[16] These values may reflect individual participation in exercise and sports as part of habitual activity. The impact of these activities must be considered separately if we are to identify a value more typical of unintervened daily activity. Welk et al.[29] reported values of approximately 7400 steps on days without physical activity (again in the same young and active sample described in section 1). Bassett et al.[41] instructed their sample (average age

40 years) to remove the pedometer during sports/recreation and reported approximately 6000 steps/day. Tudor-Locke et al.[42] described similar values (i.e. 6000 steps/day) for non-exercise weekdays in a sample whose average age was 69 years. It appears then, that for otherwise healthy adults, the current evidence supports ≈6000–7000 steps/day as indicative of usual daily activity (outside the scope of volitional physical activity such as sport or exercise). This in turn suggests that values lower than this range could be used to classify sedentarism.

3. How Many Steps/Day Are Indicative of Sedentarism?

There continues to be no consensus on the definition of sedentarism.[1,43] Sedentarism has been traditionally inferred using comparatively low levels of total energy expenditure, time or distance walked, stairs climbed, and/or through lack of self-reported participation in vigorous leisure activities, including sports and exercise.[43] A specific 'sedentary lifestyle index'[44] would be helpful for screening and recruiting purposes (i.e. to identify those who would most likely benefit from appropriate intervention) as well as for surveillance. In a study of 109 adults monitored for up to 21 consecutive days, individuals with pedometer values lower than ≈5000 steps/day (representing the 25th percentile of distribution of this sample's data) were more likely to be classified as obese (according to accepted body mass index [BMI] cut points) than individuals who took more than ≈9000 steps/day (who were also more likely to be classified as normal weight). Although this evidence is considered preliminary, it may be appropriate to use <5000 steps/day as a sedentary lifestyle index that is likely associated with a number of chronic conditions and untoward health outcomes. A remaining question then is, how many steps are equivalent to public health recommendations?

4. How Many Steps Are Equivalent to Public Health Recommendations?

As stated in section 1, public health guidelines recommend at least 30 accumulated minutes of moderate-intensity physical activity on most, if not all, days of the week.[2,6] Welk et al.[29] extrapolated the number of steps taken in 30 minutes of walking (approximately 3800–4000 steps) from their distance-walked data but a direct measurement of this index is preferable for implementation purposes. Sedentary but otherwise healthy women recorded approximately 3100 steps during an unsupervised 30-minute walk (intensity not reported) included in a typical day of activity.[30] Directly measured, healthy older adults (age 59–80 years) took 3411 ± 577 steps in 30 minutes of continuous, self-paced walking in a group programme (which may have influenced walking pace).[42]

A directly-measured and reliable index for steps taken in 30 minutes of at least moderate-intensity walking is needed, although it is likely to fall between 3000–4000 steps. Such an index could be used to interpret change due to intervention and also to prescribe an appropriate health-related physical activity increment. If used to prescribe increased physical activity, it is important to emphasise that this index should: (i) reflect activity that is at least of moderate intensity (e.g. brisk walking); and (ii) be taken 'over and above' usual daily values (below which individuals might be classified as sedentary) on a regular basis. Furthermore, if we accept that 6000–7000 steps/day is indicative of usual daily activity, then the addition of 3000–4000 steps/day of moderate intensity results in 9000–11 000 steps/day, in fair agreement with the 10 000 steps/day guideline. It remains plausible, however, that some individuals could accumulate 30 minutes of moderate-intensity activity with fewer steps/day.[45]

5. Remaining Concerns

To be considered appropriate, any endorsed step index for daily activity should be both 'efficacious' (i.e. it should produce the desired health benefits) and 'sustainable' (i.e. it should be relatively easy to continue over the long term). In turn, sustainability infers that it must first be achievable 'in the short term'. Neither efficacy nor sustainability considered alone would be sufficient to deem any recommended step index appropriate.

Preliminary evidence suggests that a goal of 10 000 steps/day may not be sustainable for some groups, including older adults and those living with chronic diseases. These individuals typically average between 3500–5500 steps/day[16] and would be primarily classified as sedentary according the proposed sedentary lifestyle index herein. In one study,[42] healthy older adults achieved only 6559 ± 2956 steps/day (and less than half attained 10 000 steps/day on any day of 9 days of monitoring) despite attending a structured exercise class 2–3 times during the week in addition to frequent self-initiated informal walking for exercise. Thus, a goal of 10 000 steps/day might be inappropriate for this group, although there are likely to be notable individual exceptions.

We have little information about the long-term sustainability of 10 000 steps/day. Iwane et al.[33] reported experiences with promoting a 10 000 steps/day walking programme among manufacturing workers. Of the initial 730 study volunteers, 306 remained in the study after 4 weeks, and only 83 remained after 12 weeks, equivalent to an 89% drop out rate! However, since their primary research question focused on the effects of walking 10 000 steps/day on blood pressure, continued inclusion in the study required unwavering compliance to the step goal. Such rigour likely over-exaggerates attrition and underestimates true sustainability of this goal. Furthermore, few details were reported to describe initial recruitment into the programme (e.g. compulsory versus volitional workplace programme). Additional studies are warranted before we rule out the sustainability of a 10 000 steps/day or any other type of pedometer-based physical activity recommendation.

One remaining concern about using 10 000 steps/day as a universal step goal is that it is too low for children, an important target population in the war against obesity.[46] UK children (aged 8–10 years) already take 12 000–16 000 steps/day.[47] A comparable study of 6- to 12-year-old US children reported that they typically take 11 000–13 000 steps/day.[48] Since childhood obesity is higher in the US than in the UK,[49] it does not make sense to set a step index lower than current norm references. The 2001–2002 President's Challenge Physical Activity and Fitness Awards Program[50] also recognised that the popular 10 000 steps/day index was likely to be too low for young people by recommending instead that children accumulate 11 000 steps (for girls) to 13 000 steps (for boys) at least 5 days a week for a standard healthy base. Although these indices are more in line with the published US sample,[48] the efficacy (i.e. to prevent or decrease overweight and obesity in youth) of even this echelon of steps/day is unknown at this time.

6. Conclusions and Research Directions

Accurate quantification of physical activity behaviours is important to epidemiologists, physiologists and behavioural scientists, as well as to health practitioners challenged to address the public health threat of sedentarism. In addition, researchers and practitioners require specific quantitative indices (i.e. benchmarks, cut points) for screening, surveillance, intervention and programme evaluation. For example, <5000 steps/day may be used as a sedentary lifestyle index to screen those individuals who could most benefit from a physical activity intervention. In the same way, we can use such indices to monitor, compare and track population trends of sedentarism.

Indices might also be used to guide and evaluate intervention efforts. Guideline statements are intended to assist with individual prescription but of necessity must be general, rather than individual in nature.[51] Practitioners must duly engage in both the art and science of physical activity prescription when interpreting any guidelines for individual application. That being said, we propose the following preliminary indices be used to classify pedometer-determined physical activity in healthy adults: (i) <5000 steps/day may be used as a 'sedentary lifestyle index'; (ii) 5000–7499 steps/day is typical of daily activity excluding volitional sports/exercise and might be considered 'low active'; (iii) 7500–9999 likely includes some volitional activities (and/or elevated occupational activity demands) and might be considered 'somewhat active'; and (iv)

≥10 000 steps/day indicates the point that should be used to classify individuals as 'active'. Individuals who take >12 500 steps/day are likely to be classified as 'highly active'. There is no evidence at this time to suggest an index indicative of excessive activity associated with health decrements. We smoothed the categories to 2500 steps/day increments purely for convenience purposes.

These preliminary step indices are referenced against both normative and criterion data. Criterion-referenced indices are best set based on their likelihood to elicit a desired outcome,[52] for example, healthy BMI or blood pressure. Future epidemiological studies should attempt to evaluate and refine particular indices associated with important health outcomes (i.e. indicative of efficacy, such as obesity, cardiovascular disease, diabetes) and long-term behavioural sustainability in different populations. Concurrently, we need to facilitate sustainability by advocating social and environmental supports associated with increased steps/day while simultaneously promoting individual control over the number and patterns of steps taken. There is much work to be done in this new line of scholarly inquiry if pedometers are to be used effectively in both research and practice to increase physical activity behaviours.

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References

1. Tudor-Locke C, Myers AM. Challenges and opportunities for measuring physical activity in sedentary adults. Sports Med 2001; 31 (2): 91-100
2. US Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta (GA): US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Promotion, 1996
3. Centers for Disease Control and Prevention. Physical activity trends: United States, 1990-1998. MMWR Morb Mortal Wkly Rep 2001; 50 (09): 166-9
4. Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999-2000. JAMA 2002; 288 (14): 1723-7
5. Masse LC, Ainsworth BE, Tortolero S, et al. Measuring physical activity in midlife, older and minority women: issues from an expert panel. J Womens Health 1998; 7 (1): 57-67
6. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995; 273 (5): 402-7
7. Freedson PS, Miller K. Objective monitoring of physical activity using motion sensors and heart rate. Res Q Exerc Sport 2000; 71 (2): 21-9
8. Bassett Jr DR. Validity and reliability issues in objective monitoring of physical activity. Res Q Exerc Sport 2000; 71 (2): 30-6
9. Moreau KL, DeGarmo R, Langley J, et al. The effectiveness of the ACSM-CDC physical activity recommendation in lowering blood pressure in postmenopausal women. Med Sci Sports Exerc 2000; 32 (S1): 72
10. Tudor-Locke C, Myers AM, Rodger NW. Formative evaluation of The First Step Program: a practical intervention to increase daily physical activity. Can J Diabetes Care 2000; 24 (4): 34-8
11. Williams PT. Physical fitness and activity as separate heart disease risk factors: a meta-analysis. Med Sci Sports Exerc 2001; 33 (5): 754-61
12. Bassett Jr DR, Ainsworth BE, Leggett SR, et al. Accuracy of five electronic pedometers for measuring distance walked. Med Sci Sports Exerc 1996; 28 (8): 1071-7
13. Hendelman D, Miller K, Baggett C, et al. Validity of accelerometry for the assessment of moderate intensity physical activity in the field. Med Sci Sports Exerc 2000; 32 (9): S442-S50
14. Le Masurier G, Tudor-Locke C. Comparison of pedometer and accelerometer accuracy under controlled conditions. Med Sci Sports Exerc 2003 May; 35 (5): 867-71
15. Tudor-Locke C, Williams JE, Reis JP, et al. Utility of pedometers for assessing physical activity: convergent validity. Sports Med 2002; 32 (12): 795-808
16. Tudor-Locke C, Myers AM. Methodological considerations for researchers and practitioners using pedometers to measure physical (ambulatory) activity. Res Q Exerc Sport 2001; 72 (1): 1-12
17. Tudor-Locke C, Myers AM, Rodger NW. Development of a theory-based daily activity intervention for individuals with type 2 diabetes. Diabetes Educ 2001; 27 (1): 85-93
18. Bassett Jr DR, Strath SJ. Use of pedometers to assess physical activity. In: Welk GJ, editor. Physical activity assessments for health-related research. Champaign (IL): Human Kinetics Publishers, Inc., 2002: 163-78
19. Tudor-Locke C. Taking steps toward increased physical activity: using pedometers to measure and motivate. Res Digest 2002; 3 (7): 1-8
20. US Surgeon General. Surgeon General's report on physical activity and health: from the Centers for Disease Control and Prevention [abstract]. JAMA 1996; 276 (7): 522
21. Institute of Medicine. Dietary reference intakes for energy, carbohydrates, fiber, fat, protein and amino acids (macronutrients). Washington, DC: National Academy of Sciences, 2002 Sep 5
22. Krucoff C. Popular, low-cost pedometers: 10,000 steps to a better health. The Seattle Times 1999 Dec 5
23. Spilner M, Robertson S. Take 10,000 a day! Prevention 2000, 90
24. DeSa P. Easy steps to shape up and slim down. Prevention 2001; Jul: 150-7
25. Kosta E. Make every step count. Walking 2001; 16: 100-1
26. Lindberg R. Active living: on the road with the 10,000 steps program. J Am Diet Assoc 2000; 100 (8): 878-9

27. Hill JO, Wyatt HR, Reed GW, et al. Obesity and the environment: where do we go from here? Science 2003; 299 (5608): 853-5
28. Hatano Y. Use of the pedometer for promoting daily walking exercise. ICHPER 1993; 29: 4-8
29. Welk GJ, Differding JA, Thompson RW, et al. The utility of the Digi-walker step counter to assess daily physical activity patterns. Med Sci Sports Exerc 2000; 32 (9): S481-S8
30. Wilde BE, Sidman CL, Corbin CB. A 10,000 step count as a physical activity target for sedentary women. Res Q Exerc Sport 2001; 72 (4): 411-4
31. Tudor-Locke C, Ainsworth BE, Whitt MC, et al. The relationship between pedometer-determined ambulatory activity and body composition variables. Int J Obes 2001; 25: 1571-8
32. Yamanouchi K, Takashi T, Chikada K, et al. Daily walking combined with diet therapy is a useful means for obese NIDDM patients not only to reduce body weight but also to improve insulin sensitivity. Diabetes Care 1995; 18 (6): 775-8
33. Iwane M, Arita M, Tomimoto S, et al. Walking 10,000 steps/day or more reduces blood pressure and sympathetic nerve activity in mild essential hypertension. Hypertens Res 2000; 23: 573-80
34. Moreau KL, Degarmo R, Langley J, et al. Increasing daily walking lowers blood pressure in postmenopausal women. Med Sci Sports Exerc 2001; 33 (11): 1825-31
35. Swartz AM, Thompson DL. Increasing daily walking improves glucose tolerance in overweight women. Res Q Exerc Sport 2002; 73 Suppl.: A16
36. The 10 000 Steps Rockhampton Project [online]. Available from URL: http://10000steps.cqu.edu.au/ [Accessed 2003 Nov 5]
37. Sugiura H, Kajima K, Mirbod SM, et al. 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
38. Tudor-Locke C, Myers AM, Bell RC, et al. Preliminary outcome evaluation of The First Step Program: a daily physical activity intervention for individuals with type 2 diabetes. Patient Educ Couns 2002; 47 (1): 23-8
39. Tudor-Locke C. Manpo-kei: the art and science of step counting. Victoria (BC): Trafford Publishing Inc, 2003
40. America on the move [online]. Available from URL: http://www.coloradoonthemove.org [Accessed 2003 Nov 5]
41. Bassett Jr DR, Cureton AL, Ainsworth BE. Measurement of daily walking distance: questionnaire versus pedometer. Med Sci Sports Exerc 2000; 32 (5): 1018-23
42. Tudor-Locke C, Jones GR, Myers AM, et al. Contribution of structured exercise class participation and informal walking for exercise to daily physical activity in community-dwelling older adults. Res Q Exerc Sport 2002; 73 (3): 350-6
43. Bernstein MS, Morabia A, Sloutskis D. Definition and prevalence of sedentarism in an urban population. Am J Public Health 1999; 89 (6): 862-7
44. Jebb SA, Moore MS. Contribution of a sedentary lifestyle and inactivity to the etiology of overweight and obesity: current evidence and research issues. Med Sci Sports Exerc 1999; 31 (11): S534-S41
45. Tudor-Locke C, Ainsworth BE, Thompson RW, et al. Comparison of pedometer and accelerometer measures of free-living physical activity. Med Sci Sports Exerc 2002; 34 (12): 2045-51
46. US Department of Health and Human Services. The Surgeon General's call to action to prevent and decrease overweight and obesity. Rockville (MD): US Department of Health and Human Services, Public Health Service, Office of the Surgeon General, 2001
47. Rowlands AV, Eston RG, Ingledew DK. Relationship between activity levels, aerobic fitness, and body fat in 8- to 10-yr-old children. J Appl Physiol 1999; 86 (4): 1428-35
48. Vincent SD, Pangrazi RP. An examination of the activity patterns of elementary school children. Pediatr Exerc Sci 2002; 14 (4): 432-41
49. Cole TJ, Bellizzi MC, Flegal KM, et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000; 320 (7244): 1240-3
50. President's Council on Physical Fitness and Sports. The President's Challenge Physical Activity and Fitness Awards Program. Bloomington (IN): President's Council on Physical Fitness and Sports, US Department of Health and Human Services, 2001
51. Corbin CB, Le Masurier G, Franks BD. Making sense of multiple physical activity recommendations. Res Digest 2002; 3 (19): 1-8
52. Corbin CB, Pangrazi RP. Are American children and youth fit? Res Q Exerc Sport 1992; 63 (2): 96-106

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