Loughborough University

This item was submitted to Loughborough's Research Repository by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Increasing our understanding of reactivity to pedometers in adults

PLEASE CITE THE PUBLISHED VERSION

http://dx.doi.org/10.1249/MSS.0b013e31818cae32

PUBLISHER

© American College of Sports Medicine

VERSION

AM (Accepted Manuscript)

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Clemes, Stacy A., and Richard A.A. Parker. 2019. “Increasing Our Understanding of Reactivity to Pedometers in Adults”. figshare. https://hdl.handle.net/2134/15571.

Loughborough University

This item was submitted to Loughborough's Institutional Repository (https://dspace.lboro.ac.uk/) by the author and is made available under the following Creative Commons Licence conditions.

creative commons

COMMONS DEED

Attribution-NonCommercial-NoDerivs 2.5

You are free:

- to copy, distribute, display, and perform the work

Under the following conditions:



Attribution. You must attribute the work in the manner specified by the author or licensor.



Noncommercial. You may not use this work for commercial purposes.



No Derivative Works. You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

This is a human-readable summary of the Legal Code (the full license).

Disclaimer

For the full text of this licence, please go to:
http://creativecommons.org/licenses/by-nc-nd/2.5/

Increasing our understanding of reactivity to pedometers in adults

Stacy A Clemes and Richard A A Parker

Institutional affiliation of both authors:

Department of Human Sciences, Loughborough University

Corresponding Author: Dr Stacy A Clemes

Corresponding Author Address:

Department of Human Sciences

Loughborough University

Leicestershire

LE11 3TU, UK

Telephone: +44 1509 228170

Fax: +44 1509 223940

Email: S.A.Clemes@lboro.ac.uk

Running title: Pedometer reactivity in adults

Funding: No external funding supported the work outlined in the manuscript, the study was conducted using resources already available within the Department of Human Sciences.

ABSTRACT

Purpose: To investigate the presence of reactivity, if any, to wearing sealed and unsealed pedometers, with and without step count recording.

Methods: On the first visit to the laboratory 63 participants (41 female, 22 male: age = 23.6±9.6 years, BMI = 22.7±3.0 kg/m^2), blinded to the study aim, were provided with a sealed pedometer (New Lifestyles NL-1000) and informed that it was a 'Body Posture Monitor' (covert monitoring). Participants wore the pedometer throughout waking hours for 1 week. Upon return to the laboratory, stored step counts were downloaded and participants were informed that the device was a pedometer. Participants wore the pedometer under 3 more conditions – sealed, unsealed, and unsealed plus logging daily steps in an activity diary - each having a duration of 1 week. The order of participation in each condition (sealed/unsealed/diary) was balanced across participants. Mean daily step counts recorded during the 4 conditions were compared using a repeated-measures ANOVA.

Results: There was a significant overall effect of condition ($p<0.001$) (covert monitoring = 8362±2600 steps/day; sealed condition = 8832±2845 steps/day; unsealed condition = 9176±3299 steps/day; diary condition = 9635±2709 steps/day), with post hoc analyses revealing that mean step counts were significantly higher in the diary condition than those reported during both the covert and sealed conditions (both $p<0.003$). No significant gender effects were observed ($p=0.33$)

Conclusion: The greatest increase in step counts occurred in the diary condition, suggesting that reactivity to pedometers is greatest when participants are requested to wear an unsealed pedometer and record their step counts. This has validity implications for short-term pedometer

studies investigating habitual free-living activity that require participants to provide a daily log of their step counts.

Keywords: habitual activity, objective assessment, sealed pedometers, unsealed pedometers, activity diary, covert monitoring

INTRODUCTION

Paragraph number 1 Walking is reported as the most popular form of leisure time physical activity in both the UK (16) and US (30), yet walking, or ambulatory activity is typically under reported in questionnaire based surveys of physical activity (1,25,37). Due to the high levels of physical inactivity reported in the UK (15,18) and US (23), coupled with the increasing public health burden of obesity (20), and other diseases related to physical inactivity (2), valid and reliable objective measures of habitual free-living activity are necessary in order to address these current public health concerns (2,21,33).

Paragraph number 2 Pedometers are increasingly being used as a surveillance tool to objectively assess ambulatory activity levels and patterns in different populations (5,8,10,11,19,22,31,32,36,40). They provide an inexpensive, accurate and reliable, objective measure of ambulatory activity by counting the number of steps taken per day, enabling the accumulative measurement of occupational, leisure time and household activity, along with activity required for everyday transportation (19). In addition to their use as a surveillance tool, pedometers are also a popular motivational device. The ability of the individual to receive immediate feedback on their accumulated step count is an important feature of the motivational aspect of the pedometer (21,26).

Paragraph number 3 When used as a measurement tool, researchers often provide participants with unsealed pedometers (no restriction on participants viewing their step count) and request that they record their daily step count in an activity diary/step log. The impact of wearing a pedometer, and recording daily step counts, on participants' activity level (i.e. daily step count)

has received little attention however. If activity changes as a result of wearing the pedometer, defined as reactivity(39), this could affect the validity of pedometer-determined activity data.

Paragraph number 4 To date, little research has investigated whether reactivity exists in adult populations when participants wear an unsealed pedometer and record daily step counts (7,12,17,21). Matevey et al. (21) and Eastep et al. (17) both reported minimal differences between unsealed and sealed (when the visible display of the pedometer is restricted) step counts, while Behrens and Dinger (7) reported no evidence of reactivity occurring in response to wearing an accelerometer and an unsealed pedometer. Similar findings have been reported when pedometer reactivity has been assessed in children (24,27,38).

Paragraph number 5 In the research outlined above (7,21,24,27,38) participants have in the sealed condition all been aware that they were wearing a pedometer, or a device that measures physical activity (17), which in itself may elicit some degree of reactivity. Only when participants are unaware that their activity levels are being monitored (termed covert monitoring) can a true investigation into reactivity be undertaken (6).

Paragraph number 6 In the only study to date employing covert monitoring, Clemes et al.(12) reported an increase in mean daily step counts of 1845 steps/day when participants wore an unsealed pedometer and recorded their daily steps in an activity log, relative to the covert condition. There are a number of mechanisms that could account for this observed increase in activity. These include: 1) the participants' knowledge that they were wearing a pedometer, and that their daily step counts were being measured; 2) the feedback obtained from the pedometer's

visible display - it has been suggested that the pedometers ability to provide individuals with immediate feedback may serve as a behavioural modification tool (26); and 3) the requirement for participants to complete a daily step log, which may have further heightened participant's awareness of their daily step count. It was unclear from this study, however, which of the above mechanisms caused the observed increase in daily step counts. The aim of the current study, therefore, was to increase our understanding of pedometer reactivity in adults by investigating the presence, if any, of pedometer reactivity in response to the three mechanisms proposed above, by assessing reactivity in response to wearing sealed and unsealed pedometers, with and without step count recording.

METHODS

Participants

Paragraph number 7 A convenience sample of 63 adult participants, blinded to the study aim, volunteered to participate. Participants were recruited from the staff and student population at Loughborough University. A health screen completed prior to enrolment into the study confirmed that participants were all in good general health and none had any physical illnesses or disabilities that might affect their normal daily routine. The study received ethical approval from the Loughborough University Ethical Advisory Committee, and participants provided written informed consent. At the study outset, body mass (kg) and height (cm) were directly measured without shoes using electronic weighing scales (Tanita UK Ltd) and a wall-mounted stadiometer (Seca UK). BMI was calculated as kg/m^2.

Pedometer

Paragraph number 8 The New Lifestyles NL-1000 pedometer (New Lifestyles, Inc., Lees Summit, MO) was used in this study. This pedometer uses the same piezo-electric mechanism as the NL-2000 pedometer which has been shown to accurately detect steps taken in both laboratory (13,14,29) and free-living conditions (28). The NL pedometer range all have internal memory chips and are capable of storing up to 7 days of data, in 1-day epochs. Their internal clock resets the step count at midnight.

Procedure

Paragraph number 9 During the first visit to the laboratory, participants were issued with a sealed pedometer and informed that the device was a 'new body posture monitor that measures time spent in horizontal, seated and standing postures' (*covert condition*). The tape used to seal the pedometer would tear if removed, therefore non-compliance would be obvious when participants returned to the laboratory. Participants were shown the correct position to wear the device, on the midline of the thigh, and were requested to wear it throughout waking hours for seven days, only removing when either bathing, showering or swimming.

Paragraph number 10 During the second visit to the laboratory, daily step counts measured from the past seven days were recorded into an activity log by an experimenter using the NL-1000's memory function. Participants were informed that the device was actually a pedometer and they were invited to participate in a further three study conditions, each condition having a duration of one week. All participants took part in each of the three remaining conditions. These conditions comprised a *sealed condition* whereby the pedometer was re-sealed and worn

throughout waking hours for seven days. As in the covert condition, in the sealed condition the pedometer's visible display was restricted. However, unlike the covert condition, participants were aware that they were wearing a pedometer and that their step counts would be retrieved by the experimenter at the end of the condition. An *unsealed condition* involved participants wearing the pedometer unsealed, whereby there was no restriction on the participants' viewing their step counts, and a *diary condition* involved participants wearing the pedometer unsealed, with the additional task of recording their daily step counts in an activity log provided, upon going to bed each night. For the two unsealed conditions, participants were shown how to use the pedometer's memory function. Following each condition, participants returned to the laboratory where the step counts were recorded by the experimenter, using the memory function. The order of the three conditions that followed the covert condition were balanced across participants, with 21 participants commencing the remainder of the study in the sealed condition (followed by the unsealed and diary conditions), 21 commencing with the unsealed condition (followed by the diary and sealed conditions), and 21 starting with the diary condition (followed by the sealed and unsealed conditions). In addition to balancing the order of the three conditions, as step counts have been shown to vary between weekdays and weekend days (4,7,10,11,34,35), the day of the week that participants commenced the covert condition, and the remaining three conditions, were also balanced across participants with 9 participants beginning the study on each day of the week, i.e. 9 participants commenced each condition on a Monday, 9 participants commended each condition on a Tuesday, 9 on a Wednesday etc.

Statistical Analyses

Paragraph number 11 Statistical analyses were conducted using SPSS for Windows version 15. Participants' mean daily step counts from each condition (covert, sealed, unsealed and diary) were calculated and compared using a repeated measures ANOVA, with gender as a between-subjects factor. Bonferroni adjusted pairwise comparisons were performed in the event of an overall significant effect of condition. Within each condition, to investigate any changes in step counts with the study day (i.e. sealed day 1, sealed day 2 etc.), daily step counts recorded during each condition were compared using a repeated measures ANOVA, with gender as a between subjects factor. Daily step counts from each condition were also organised according to the day of the week and compared using a repeated measures ANOVA, with gender as a between subjects factor, to test whether mean step counts differed between days. In the event of a significant study day-order, or day-of-the-week effect, Bonferroni corrected post hoc comparisons were undertaken. Statistical significance was set at $P < 0.05$.

RESULTS

Participants

Paragraph number 12 Demographic characteristics of the sample are summarised in Table 1. There were no significant gender differences in terms of age and BMI.

Insert Table 1 about here

Overall effects of condition

Paragraph number 13 Following the covert and sealed conditions there was no evidence of any tampering with the pedometer seal, confirming that all participants were blinded to their step counts in these conditions, and to the fact that they were wearing a pedometer in the covert condition. Furthermore, following the covert condition, when asked by an experimenter if they knew what the device that they had been wearing over the past seven days actually was, 46 participants responded that it was a body posture monitor while 17 said that they weren't sure what the devise actually was. Mean step counts recorded from each condition are shown in Table 2. There was a statistically significant difference between mean step counts recorded in each condition ($F = 7.0$, $P < 0.001$), with post hoc analyses revealing that mean step counts recorded in the diary condition were significantly higher than those recorded in both the covert ($t = 5.2$, $P < 0.001$) and sealed ($t = 3.3$, $P = 0.002$) conditions. There was no significant gender interaction, or main effect, indicating that males and females responded similarly to the four study conditions.

Insert Table 2 about here

The influence of study day order in each condition

Paragraph number 14 Whilst mean step counts recorded in the sealed and unsealed conditions did not differ significantly to those recorded in the covert condition, there was a tendency for mean step counts to be higher during the first few days of monitoring in these conditions. Decreases in mean daily step counts are particularly evident in these conditions across the seven days of monitoring suggesting that reactivity was present to some degree during the first three to

four days of the sealed and unsealed conditions (Figure 1). Significant differences between the step counts recorded in both the sealed ($F = 3.1$, $P = 0.006$) and unsealed ($F = 2.2$, $P = 0.04$) conditions were observed across the monitoring frame with post hoc analyses revealing that in the sealed condition, step counts recorded on day 1 were significantly higher than those recorded on days 5 and 6 (both $P < 0.002$), and in the unsealed condition, step counts recorded on day 1 were significantly higher than those recorded on days 5 and 7. There were no significant overall effects of study day order in both the covert and diary conditions. In addition, within each condition there were no significant gender interactions, or main effects, indicating that males and females responded similarly to all conditions. It can be observed from Figure 1 that while in the diary condition there is a tendency for mean daily step counts to decrease slightly over the seven day monitoring period, the step counts recorded in this condition do not return to the levels observed in the covert condition.

Insert Figure 1 about here

Day-of-the-week effects

Paragraph number 15 A significant day-of-the-week effect was evident in each condition (all $P < 0.05$), with post hoc analyses revealing that mean step counts reported on a Sunday were significantly lower than those reported on all other days (all $P < 0.002$) (Figure 2). Within each condition there were no significant gender interactions, or main effects, indicating that males and females had similar activity levels and patterns over the different days of the week.

DISCUSSION

Paragraph number 16 The aim of the current study was to add to the understanding of pedometer reactivity in adults by investigating the presence of reactivity, if any, in response to wearing sealed and unsealed pedometers, with and without step count recording. This study is one of few that have employed covert monitoring to investigate the true presence of pedometer reactivity in an adult sample (12). In the participants surveyed, the greatest increases in daily step counts were observed in the diary condition, with mean step counts recorded in this condition being significantly higher than those observed in both the covert (+1273, SD = 1963, steps/day) and sealed (+803, SD = 1954, steps/day) conditions.

Paragraph number 17 The increase in daily step counts observed in the diary condition in the current study, support the findings of an earlier study employing covert monitoring to investigate the presence of pedometer reactivity in an adult sample (12). Clemes et al. (12) reported a significant increase in mean daily step counts when participants wore an unsealed pedometer and recorded their daily step counts in an activity log, relative to a covert monitoring condition. It was unclear, however, from this study what mechanisms caused the increase in daily step counts, and three potential contributory factors were highlighted, including: 1) the participants' knowledge that they were wearing a pedometer, 2) the feedback obtained from the pedometer's visible display, and 3) the requirement for participants to complete a daily step log. The current study aimed to increase our understanding of pedometer reactivity in adults by investigating the presence, if any, of pedometer reactivity in response to the three factors proposed above. The current findings suggest that the requirement of participants to record their daily step counts into an activity log elicits the greatest degree of reactivity. It is speculated that the act of recording

daily step counts into an activity log heightens participant's awareness of their overall activity levels, which may lead to personal goal setting, and/or a greater self-efficacy (confidence) for walking (3), resulting in increases in daily activity. For example, in a minimal contact pedometer intervention study, Rooney et al. (26) observed that women who chose to make a note of their daily step count were more aware of their general activity levels and as a result were more likely to set challenging activity goals.

Paragraph number 18 The duration of this reactivity effect in response to step count recording has yet to be determined. When assessing mean daily step counts in the diary condition according to study day order, it is evident from Figure 1 that whilst there was a tendency for step counts to be higher during the first two days of this condition followed by a slight decrease and levelling off over days 3 to 7, the step counts recorded over days 3 to 7 do not return to the levels observed in the covert condition. These findings suggest that reactivity to wearing a pedometer and recording daily step counts may last for slightly longer than one week. In addition, there were no significant overall effects of study day order in the diary condition, supporting the suggestion that in this condition daily step counts remained elevated throughout the seven day monitoring period, and systematic reductions in daily step counts over this period were negligible. These findings support observations made by Clemes et al. (12) in their study investigating pedometer reactivity, who also reported no effects of study day order in their diary condition. The current findings also support earlier suggestions made by Eastep et al. (17) in relation to the potential duration of pedometer reactivity following the comparison of sealed and unsealed step counts from 21 participants enrolled in a 'Walking for Fitness' class. While no differences in mean step counts were observed between the two study conditions, Eastep et al.

(17) did observe that walking behaviour decreased in a linear fashion throughout the two three-week conditions, suggesting that some degree of reactivity was present in both. It was concluded from this research that a pedometer "feedback effect" may be present, but it may only last between one and two weeks (17).

Paragraph number 19 Whilst overall mean step counts recorded in the sealed and unsealed conditions were slightly higher than those recorded in the covert condition, these differences between conditions were not statistically significant, indicating at first glance that reactivity to both sealed and unsealed (without step count recording) pedometers is minimal. However, when assessing mean step counts within each condition according to study day order, it is evident from Figure 1 that step counts appear to be highest during the first day of monitoring in the sealed and unsealed conditions followed by a gradual reduction in mean daily steps over the remainder of the two seven day monitoring frames. In both the sealed and unsealed conditions, mean step counts from approximately day 4 onwards approach a level comparable with mean daily step counts recorded in the covert condition (Figure 1). It is suggested therefore, that in the sample studied, reactivity was present at the beginning of both the sealed and unsealed conditions, however it appeared to be relatively short-lived in these conditions. This finding has methodological considerations for researchers wishing to use sealed and/or unsealed pedometers in adults for ambulatory activity surveillance purposes, and it is recommended that the first three days of monitoring be treated as a familiarisation period only, with the step counts recorded on the subsequent days being used as the primary data. Further research is required, however, to determine the duration of reactivity associated with wearing unsealed pedometers and recording daily step counts in an activity diary/step log.

Paragraph number 20 It has recently been suggested that seven days of pedometer monitoring are sufficient to reliability estimate monthly habitual activity (9). In line with the current findings however it is suggested that, until the duration of the reactivity effect in response to step count recording has been established, that researchers wishing to use unsealed pedometers with step count recording for activity surveillance purposes provide participants with a suitable familiarisation period (>1 week) with the pedometer and diary prior to this seven day monitoring phase.

Paragraph number 21 As widely reported elsewhere (4,7,10,11,34,35), a significant day-of-the-week effect was observed across all conditions in the current study, with step counts recorded on a Sunday being significantly lower than those recorded on all other days. To counterbalance the anticipated day-of-the-week effect, allowing for the true observation of any reactivity in terms of study day order to be observed, a counter-balanced repeated measures study design was employed. Equal numbers of participants (n = 9) began each condition on each day of the week, therefore the changes in step counts that occurred over the seven days of monitoring within each condition, shown in Figure 1, represent changes caused by study day order, and they are not confounded by any day-of-the-week effects.

Paragraph number 22 A limitation of the current study is the fact that participants were all volunteers, recruited from the staff and student population at Loughborough University. As participants responded to advertisements for volunteers to take part in a study '*evaluating a novel body posture monitor*', it is unlikely that the sample were biased towards those with an interest in

their physical activity levels, however the participants studied comprised a healthy, relatively young, normal-weight adult sample and it is recommended that the current findings are confirmed in different population groups. For example, it would be interesting to investigate whether similar responses to wearing a pedometer and recording daily step counts are seen in children, or in overweight and obese adults.

Paragraph number 23 In conclusion, in the sample surveyed, the greatest increases in daily step counts occurred in response to wearing a pedometer and recording daily step counts in an activity log, with mean step counts recorded in the diary condition being significantly higher than those observed in both the covert and sealed conditions. The duration of this reactivity effect has yet to be determined, however the results of the current study suggest that this effect may last for longer than one week. This has validity implications for short-term pedometer studies investigating habitual activity levels. Whilst mean step counts recorded in the sealed and unsealed conditions were slightly higher than those recorded in the covert condition, these differences were not statistically significant. However, in these conditions there was a tendency for step counts to be higher during the first couple of days of monitoring, suggesting that a certain degree of reactivity was present initially. The step counts recorded during the remainder of the sealed condition (days 4 to 7) were similar to those recorded during the covert condition, suggesting that the use of sealed pedometers (with the first three days treated as a familiarisation period) provide a suitable measure of habitual ambulatory activity when covert monitoring is not appropriate or feasible. The findings from the current study increase our understanding of pedometer reactivity in an adult sample, and have important implications to both researchers and

practitioners interested in the use of pedometers for the assessment of habitual ambulatory activity.

ACKNOWLEDGMENTS

We wish to thank Professor Stuart Biddle for reading through and commenting on the manuscript prior to its submission.

CONFLICTS OF INTEREST

There are no perceived conflicts of interest associated with this research. The results of the present study do not constitute endorsement by ACSM.

REFERENCES

1. Ainsworth BE, Leon AS, Richardson MT, Jacobs DR, Paffenbarger RS, Jr. Accuracy of the College Alumnus Physical Activity Questionnaire. *J Clin Epidemiol.* 1993;46:1403-11.
2. Allender S, Foster C, Scarborough P, Rayner M. The burden of physical activity-related ill health in the UK. *J Epidemiol Community Health.* 2007;61:344-8.
3. Bandura A. *Self-efficacy: The exercise of control*. New York: W.H. Freeman, 1997. p.116-137.
4. Bassett DR Jr., Cureton AL, Ainsworth BE. Measurement of daily walking distance-questionnaire versus pedometer. *Med Sci Sports Exerc.* 2000;32:1018-23.
5. Bassett DR Jr., Schneider PL, Huntington GE. Physical activity in an Old Order Amish community. *Med Sci Sports Exerc.* 2004;36:79-85.

6. Beets M. The pursuit of the reactivity: A need for a closer look. *Measurement in physical education and exercise science.* 2006;10:265-267.

7. Behrens TK, Dinger MK. Motion sensor reactivity in physically active young adults. *Res Q Exerc Sport.* 2007;78:1-8.

8. Bennett GG, Wolin KY, Puleo E, Emmons KM. Pedometer-determined physical activity among multiethnic low-income housing residents. *Med Sci Sports Exerc.* 2006;38:768-73.

9. Clemes SA, Griffiths PL. How many days of pedometer monitoring predict monthly ambulatory activity in adults? *Med Sci Sports Exerc.* 2008; In Press.

10. Clemes SA, Griffiths PL, Hamilton SL. Four-week pedometer-determined activity patterns in normal weight and overweight UK adults. *Int J Obes (Lond).* 2007;31:261-6.

11. Clemes SA, Hamilton SL, Lindley MR. Four-week pedometer-determined activity patterns in normal weight, overweight and obese adults. *Prev Med.* 2008;46:325-30.

12. Clemes SA, Matchett N, Wane SL. Reactivity: an issue for short-term pedometer studies? *Br J Sports Med.* 2008;42:68-70.

13. Crouter SE, Schneider PL, Bassett DR, Jr. Spring-levered versus piezo-electric pedometer accuracy in overweight and obese adults. *Med Sci Sports Exerc.* 2005;37:1673-9.

14. Crouter SE, Schneider PL, Karabulut M, Bassett DR, Jr. Validity of 10 electronic pedometers for measuring steps, distance, and energy cost. *Med Sci Sports Exerc.* 2003;35:1455-60.

15. Department of Health. Health Survey for England 2004 - updating of trend tables to include 2004 data. NHS Health and Social Care Information Centre, 2005. p.7.

16. Department of Health. A Report From the Chief Medical Officer: *At least five a week Evidence on the Impact of Physical Activity and Its Relationship to Health*. London: Crown Copyright, 2004. p.2.

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

18. Harrison RA, McElduff P, Edwards R. Planning to win: Health and lifestyles associated with physical activity amongst 15,423 adults. *Public Health.* 2006;120:206-212.

19. Hornbuckle LM, Bassett DR, Jr., Thompson DL. Pedometer-determined walking and body composition variables in African-American women. *Med Sci Sports Exerc.* 2005;37:1069-74.

20. James PT. Obesity: the worldwide epidemic. *Clin Dermatol.* 2004;22:276-80.

21. Matevey C, Rogers L, Dawson E, Tudor-Locke C. Lack of reactivity during pedometer self-monitoring in adults. *Measurement in physical education and exercise science.* 2006;10:1-11.

22. McCormack G, Giles-Corti B, Milligan R. Demographic and individual correlates of achieving 10,000 steps/day: use of pedometers in a population-based study. *Health Promot J Austr*. 2006;17:43-7.

23. Metzger JS, Catellier DJ, Evenson KR, Treuth MS, Rosamond WD, Siega-Riz AM. Patterns of objectively measured physical activity in the United States. *Med Sci Sports Exerc.* 2008;40:630-8.

24. Ozdoba R, Corbin C, Le Masurier G. Does reactivity exist in children when measuring activity levels with unsealed pedometers. *Pediatr Exerc Sci.* 2004;16:158-166.

25. Richardson MT, Leon AS, Jacobs DR, Jr., Ainsworth BE, Serfass R. Comprehensive evaluation of the Minnesota Leisure Time Physical Activity Questionnaire. *J Clin Epidemiol.* 1994;47:271-81.

26. Rooney B, Smalley K, Larson J, Havens S. Is knowing enough? Increasing physical activity by wearing a pedometer. *Wis Med J.* 2003;102:31-6.

27. Rowe D, Mahar M, Raedeke T, Lore J. Measuring physical activity in children with pedometers: Reliability, reactivity, and replacement of missing data. *Pediatr Exerc Sci.* 2004;16:343-54.

28. Schneider PL, Crouter SE, Bassett DR. Pedometer measures of free-living physical activity: comparison of 13 models. *Med Sci Sports Exerc.* 2004;36:331-5.

29. Schneider PL, Crouter SE, Lukajic O, Bassett DR, Jr. Accuracy and reliability of 10 pedometers for measuring steps over a 400-m walk. *Med Sci Sports Exerc.* 2003;35:1779-84.

30. Simpson ME, Serdula M, Galuska DA, Gillespie C, Donehoo R, Macera C, Mack K. Walking trends among U.S. adults: the Behavioral Risk Factor Surveillance System, 1987-2000. *Am J Prev Med.* 2003;25:95-100.

31. Swartz A, Strath S, Parker S, Miller N, Cieslik L. Ambulatory activity and body mass index in white and non-white older adults. *J Phys Act Health.* 2007;4:294-304.

32. Thompson DL, Rakow J, Perdue SM. Relationship between accumulated walking and body composition in middle-aged women. *Med Sci Sports Exerc.* 2004;36:911-4.

33. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008;40:181-8.

34. Tudor-Locke C, Bassett DR, Swartz AM, Strath SJ, Parr BB, Reis JP, Dubose KD, Ainsworth BE. A preliminary study of one year of pedometer self-monitoring. *Ann Behav Med.* 2004;28:158-62.

35. Tudor-Locke C, Burkett L, Reis JP, Ainsworth BE, Macera CA, Wilson DK. How many days of pedometer monitoring predict weekly physical activity in adults? *Prev Med.* 2005;40:293-8.

36. Tudor-Locke C, Ham SA, Macera CA, Ainsworth BE, Kirtland KA, Reis JP, Kimsey CD, Jr. Descriptive epidemiology of pedometer-determined physical activity. *Med Sci Sports Exerc.* 2004;36:1567-73.

37. Tudor-Locke CE, Myers AM. Challenges and opportunities for measuring physical activity in sedentary adults. *Sports Med.* 2001;31:91-100.

38. Vincent SD, Pangrazi RP. Does reactivity exist in children when measuring activity levels with pedometers? *Pediatr Exerc Sci.* 2002;14:56-63.

39. Welk GJ, Corbin CB, Dale D. Measurement issues in the assessment of physical activity in children. *Res Q Exerc Sport.* 2000;71:S59-73.

40. 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;37:724-30.

Table 1. Participant demographic characteristics

	Whole sample (n = 63)	Males (n = 22)	Females (n = 41)
	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	23.6 (9.6)	24.6 (9.0)	23.0 (10.0)
Height (cm)	168.6 (9.8)	179.5 (5.5)	162.8 (5.8)
Weight (kg)	64.8 (10.6)	73.0 (8.4)	60.4 (9.0)
BMI (kg/m^2)	22.7 (3.0)	22.7 (3.0)	22.7 (3.0)

Table 2. Mean daily step counts recorded in each study condition for the sample as a whole, and for males and females separately.

	Whole sample (n = 63)	Males (n = 22)	Females (n = 41)
	Mean (SD)	Mean (SD)	Mean (SD)
Covert	8362 (2600)	8994 (2189)	8022 (2760)
Sealed	8832 (2845)	9443 (1769)	8504 (3254)
Unsealed	9176 (3299)	9759 (3093)	8863 (3400)
Diary	9635 (2709)*	10848 (1980)	8984 (2841)

* Mean daily step counts recorded in the diary condition were significantly higher than those recorded in both the covert and sealed conditions. The repeated measures ANOVA revealed no main effect for gender nor a significant gender by condition interaction.

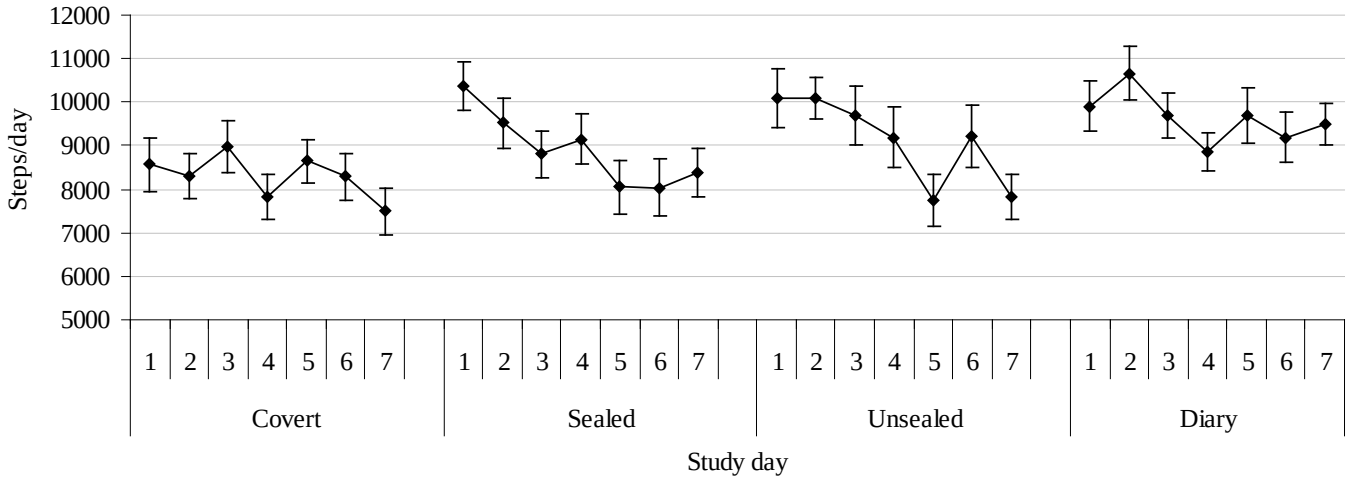


Figure 1. Mean daily step counts recorded during each study day within each condition, along with standard error bars.

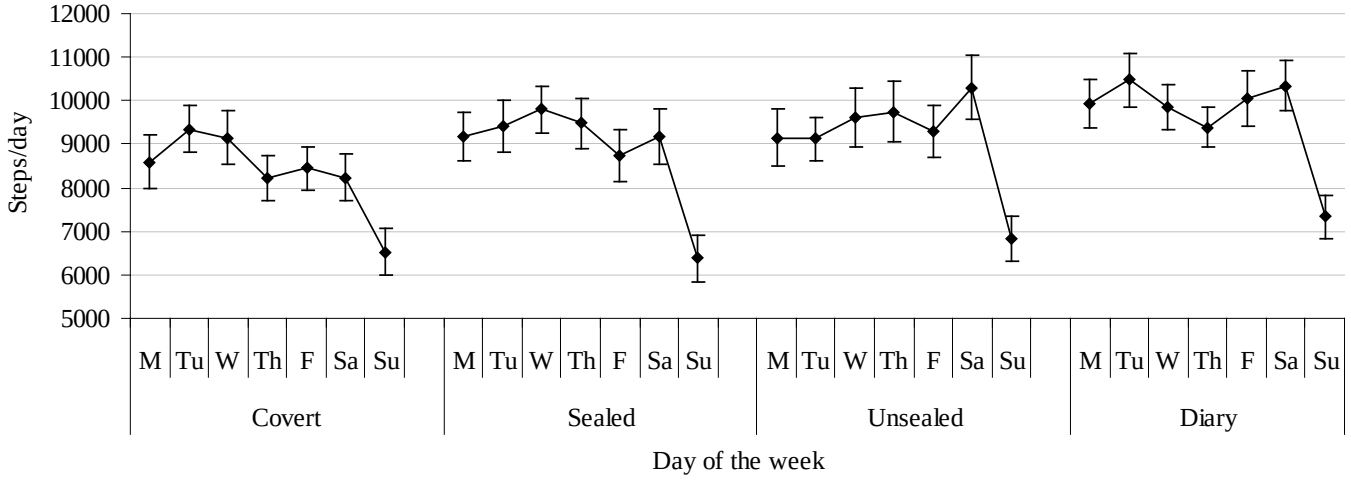


Figure 2. Mean daily step counts recorded on each day of the week in each condition, along with standard error bars