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Small Steps: Preliminary effectiveness and feasibility of an incremental goal-setting intervention to reduce sitting time in older adults

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ABSTRACT

Objective: This study aimed to evaluate the preliminary effectiveness and feasibility of a theory-informed program to reduce sitting time in older adults.
Design: Pre-experimental (pre-post) study. Thirty non-working adult (≥60 years) participants attended a one hour face-to-face intervention session and were guided through: a review of their sitting time; normative feedback on sitting time; and setting goals to reduce total sitting time and bouts of prolonged sitting. Participants chose six goals and integrated one per week incrementally for six weeks. Participants received weekly phone calls.
Outcome measures: Sitting time and bouts of prolonged sitting (≥30 min) were measured objectively for seven days (activPAL3c inclinometer) pre- and post-intervention. During these periods, a 24-h time recall instrument was administered by computer-assisted telephone interview. Participants completed a post-intervention project evaluation questionnaire. Paired *t* tests with sequential Bonferroni corrections and Cohen's *d* effect sizes were calculated for all outcomes.
Results: Twenty-seven participants completed the assessments (71.7 ± 6.5 years). Post-intervention, objectively-measured total sitting time was significantly reduced by 51.5 min per day ($p = 0.006$; $d = -0.58$) and number of bouts of prolonged sitting by 0.8 per day ($p = 0.002$; $d = -0.70$). Objectively-measured standing increased by 39 min per day ($p = 0.006$; $d = 0.58$). Participants self-reported spending 96 min less per day sitting ($p < 0.001$; $d = -0.77$) and 32 min less per day watching television ($p = 0.005$; $d = -0.59$). Participants were highly satisfied with the program.
Conclusion: The 'Small Steps' program is a feasible and promising avenue for behavioral modification to reduce sitting time in older adults.

1. Introduction

High levels of time spent in sedentary behavior (any waking behavior characterized by low rates of energy expenditure while in a sitting or reclining position) [1] have been shown to be associated with increased risk of developing cardiovascular disease, type 2 diabetes, obesity, breast and colon cancer, and premature mortality [2–4]. Accruing sedentary time in prolonged bouts may be particularly detrimental for cardio-metabolic health [5,6]. The deleterious impacts of high levels of sedentary time are also observed in older adults [7], who are the most sedentary age group of the

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population [8], with an average sedentary time of 9.4 h per day. Reducing sedentary time is an emerging target for health behavior change interventions [9].

A recent meta-analyses of interventions reporting sedentary time outcomes in adults concluded that interventions targeting physical activity (alone or in combination with sedentary time) were not effective in reducing sedentary time [10]. Limited evidence exists on interventions to specifically reduce sedentary time in older adults. Three pre-post studies have implemented goal setting interventions which included individual feedback on sedentary time [11–13]. These studies reported decreases in objectively-measured sedentary time ranging from 24 [13] to 31 min per day [11]. Two of these studies included short-term interventions of one day [11] and two weeks [13] with immediate post-intervention follow up, and the third study targeted overweight and obese older adults, therefore possibly limiting the generalisability of the findings [12].

In order to increase reductions in sedentary time and assess changes beyond the short-term nature of previous interventions, a novel, incremental goal setting intervention ('Small Steps') was developed and evaluated for feasibility and preliminary effectiveness.

2. Materials and methods

2.1. Study design

The study employed a pre-experimental (pre-post) design and complies with the STROBE guidelines for the reporting of observational studies [14]. Data were collected in Adelaide, South Australia between April and December 2014. Ethical approval was gained from the University of South Australia Human Research Ethics Committee (protocol no. 0000032457). Participants provided written informed consent.

2.2. Participants

Older adults (≥60 years) were recruited in metropolitan Adelaide, South Australia. Flyers advertising the study were placed in local government community centres, seniors clubs and groups, older adult education providers, and libraries. Wherever possible, the principal investigator (LKL) talked to groups about the study and distributed flyers face-to-face. Adults were included if they: could communicate effectively in English, lived in the metropolitan area, and worked less than two days per week (paid or voluntary). People who are working, particularly in desk jobs have less discretion over their sedentary time, and have different environmental barriers to sitting less. People were excluded if they were unable to walk independently or had a significant cognitive impairment. No formal cognitive screening was applied but potential participants needed to understand the study aims, procedures and instruments.

We required a sample of 25 participants to detect a 90 min/day reduction in sitting time (80% power, alpha 0.05) which would result in an effect size of 0.53—based on older adults' (≥60 years) mean sedentary time of 618 ± 171 min per day (unpublished self-report use of time data from 2163 older adults). We aimed to recruit 30 participants to allow for attrition.

2.3. The 'Small Steps' program

The intervention has been reported according to the Template for Intervention Description and Replication (TIDieR) [15]. The intervention was administered by either the principal investigator (LKL) or a trained research assistant (EL) and consisted of a one hour, one on one, face-to-face session in participant's homes followed by weekly supportive phone calls. Participants were guided through three activities:

1) *Review of assessed sedentary time*. Participants were provided with a workbook adapted from a previous study [11] which contained general information about sitting time and health, and individualized data (min/day) on total sitting time, and the time spent sitting while completing certain types of activities, e.g., watching TV, reading or transport. These data were derived from a use of time interview completed by participants.
2) *Normative feedback on sedentary time*. Participants were provided with a ranking (in quartiles) against the average older Australian ($n = 2163$, unpublished data) for their total sitting time, and their sitting time according to 'types' of activities (e.g., TV, reading). This feedback informed the subsequent guided goal setting (i.e., it provided informational feedback to inform self-endorsed goal setting).
3) *Guided goal setting*. The goal setting involved a collaborative 'Small Steps' approach, whereby each participant chose six ways to decrease their sitting time and break up prolonged sitting from a list of pre-specified behavioral items combined with suggestions of their own. The aim was for one goal to be integrated incrementally each week for six weeks, so that in the final week of the intervention, participants would have integrated six goals into their day to reduce sedentary time (e.g., Week 1: "*I am going to stand up during the TV ad breaks*", Week 2: "*I am going to stand up while I talk on the phone*" + Week 1 goal). Each step was designed to be easily achievable and to reduce sitting time by about 15 min/day, leading to a cumulative reduction of 90 min/day at the end of the 6-week intervention. Individually tailored feedback and a summary of the goal setting plan were provided at the end of the session. Participants were required to self-monitor their goals with a simple daily checklist (e.g., "*Today, did you achieve your goal of standing up during two TV ad breaks? Yes/No. If not, why not?*"). Weekly phone calls provided support and resolved any issues. Intervention materials are available from the principal investigator.

Small Steps was informed by constructs from self-determination theory [16] which argues that enduring behavior change arises from the satisfying of universal and innate human needs for competence (the need to feel capable and effective within activities), autonomy (the need to experience behaviors as self-endorsed, volitional, and valued), and psychological relatedness (the need to experience close and caring connections with others). The program captured each of these needs, for example, competence because the goals were modest and achievable, autonomy because participants suggested and chose their own goals within the context of making comparisons with normative data (informational feedback), and relatedness with the integration of supportive phone calls.

2.4. Outcome measures

Sitting, *standing* and *stepping* time were measured with the activPAL3 device (PAL Technologies, Glasgow, UK) which was waterproofed, attached to the anterior mid-thigh, and worn for 24 h/day for seven days at pre- and post-intervention. The activPAL is a valid and reliable measure of sitting time compared with direct observation in older adults (correlation of 0.99) [17]. Data were processed using activPAL3 software (version 7.2.28). Sitting time during waking hours was obtained from a custom-built SAS program which matched self-report non-wear and sleep time (from logs and entered into a database) to activPAL data (from events files) [18].

Use of time was measured with the Multimedia Activity Recall for Children and Adults (MARCA) which uses a structured phone interview with participants recalling their last weekday and weekend day to construct daily activity profiles [19,20]. The MARCA has demonstrated test-retest reliability in adults for sleep, physical activity levels and screen time (ICC 0.92–0.99) [20] and has been shown to be a valid measure of total daily energy expenditure [21] and physical activity levels [20]. Data on daily total sitting time (all waking activities rated as ≤1.5 METS) as well as discrete activities such as watching TV, computer use, or reading (all while sitting or reclining) were obtained from the MARCA.

Participant satisfaction and *burden* were assessed with a questionnaire administered following the post-intervention assessment. The questionnaire contained a series of 5-point Likert scale and open-ended items. The *feasibility* of the participant recruitment and management processes were assessed by evaluating uptake of the program (% of eligible participants who enrolled in the study) and retention (% of enrolled participants completing the post-intervention assessment).

2.5. Procedure

Following recruitment, participants attended a face-to-face baseline session in their own home, completed a basic demographic and health questionnaire, were measured for height and weight, and fitted with an activPAL3 monitor. Participants were asked to wear the device for 7-days, 24 h a day, including during water-based activities. During this monitoring period, participants were requested to record periods of non-wear and sleep in a log. At a pre-arranged time during the monitoring period, participants completed the MARCA. In the following week, participants underwent the intervention session. Following the intervention session, weekly phone calls were completed for the 6-week intervention period. Following the 6 week intervention period, participants completed the post-intervention assessment, including seven days of monitoring with the activPAL device, and subsequent MARCA assessment completed during this time. Participants also completed the project evaluation questionnaire at the end of this monitoring period.

2.6. Analysis

Participant characteristics, activity and use of time data, and feasibility measures were descriptively analyzed. All data were checked for normality. Paired *t*-tests (2 tailed) with sequential Bonferroni corrections were completed to account for multiple comparisons. Effect sizes (Cohen's *d*) were calculated and interpreted as small 0.20 to <0.50, medium 0.50 to <0.80, and large ≥0.80 [22]. One way analysis of variance (ANOVA) was completed to examine associations between self-reported goal achievement and changes in objectively-measured total sitting time. Significance was set at 0.05 and SPSS statistical software (version 22) was used for all analyses.

3. Results

Fig. 1 shows the flow of participants through the study. Thirty participants enrolled in the study and completed the baseline assessment. Three women (who were older and had a lower BMI than completers) withdrew prior to the post-intervention assessment (Table 1). Completers had an average of 3.0 ± 1.6 chronic conditions, including: arthritis (n = 14), back pain (n = 13), hypertension (n = 10), high cholesterol (n = 10), skin cancer (n = 9), reflux/indigestion (n = 7), depression (n = 7), cardiovascular disease (n = 5), diabetes (n = 3), migraines (n = 2), cancer (n = 1) and chronic lung disease (n = 1).

3.1. Objectively-measured outcomes

There was no difference in the number of days the device was worn between the pre- (6.9 ± 0.3 days) and post-intervention (7.0 ± 0.3 days) assessments or in waking time between the pre- (15.4 ± 0.8 h/day) and post-intervention (15.5 ± 0.8 h/day) assessments. From pre- to post-intervention, participants significantly reduced their: total daily sitting time and sitting time accrued in prolonged bouts (≥30 min), percentage of waking time spent sitting, the number of bouts of prolonged sitting, and significantly increased their daily standing time (Table 2). These outcomes remained significant following sequential Bonferroni corrections. The effect size for all of these outcomes was medium (Table 2). There was a small increase in the daily time spent stepping post-intervention, however, this was not significant.

3.2. Use of time outcomes

From pre- to post-intervention, there were significant reductions in total sitting time and in time spent watching TV; and increases in time spent in light, moderate-to-vigorous physical activity, and daily energy expenditure. However, following sequential Bonferroni correction, these differences were attenuated to non-significance (Table 3). Despite this, the physical activity and energy expenditure outcomes demonstrated a medium effect size from pre- to post-intervention (Table 3).

3.3. Satisfaction

Eighty-one per cent of participants (n = 22) reported achieving all of their goals, seven per cent (n = 3) some goals, and 11% (n = 3) did not achieve any goals. The most common goals related to sitting in front of a screen (28% of all goals set, e.g., stand up during the TV ad breaks), followed by eating and drinking (16%, e.g., stand up to eat breakfast), reading (13%, e.g., stand up when finishing a book chapter), and socialising (10%, e.g., stand up to meet friends). The least commonly set goals related to occupational activities (writing or desk work), and chores. A list of all participant goals is contained in Supplementary file 1, with each row representing a participant. Goal achievement and changes in activPAL sitting time were not significantly associated (F = 0.55, p = 0.58). Overall program satisfaction was high, with an average rating of 8.2 ± 1.8 out of 10 (range 5–10), and 8.2 ± 2.2 (range 3–10) for the likelihood of recommending the program. Most participants (81%) rated the content and quality of the intervention materials as good, and that the individual components (workbook (77%), daily checklist (85%), feedback (88%), telephone calls (96%) and ability to choose own goals (89%)) were useful. The majority of participants (93%) liked the 'Small Steps' approach of adding one goal per week and all felt supported by the research team.

3.4. Burden

The overall burden to participants was rated as low, with a mean score of 8.8 ± 1.2 out of 10 (with 10 representing '*not time consuming at all*'). Nearly all of the participants (96%) reported that the activity monitor was easy to wear, and 85% reported they enjoyed completing the use of time interviews.

3.5. Feasibility

Thirty-one of the 32 eligible participants enrolled in the study, representing an uptake of 97% (Fig. 1). Twenty-seven of the 30

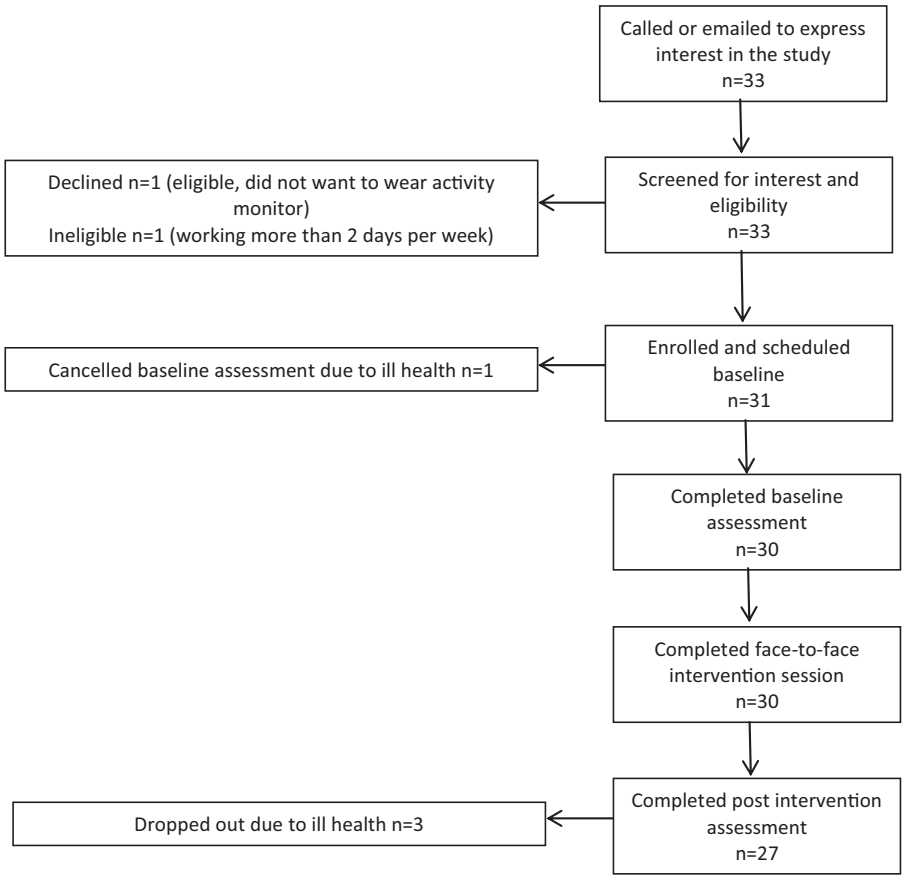

Fig. 1. Flow of participants through the study.

Table 1
Participant demographic characteristics (completers $n = 27$, non-completers $n = 3$).

Characteristic	Completers			Non-completers
	Males	Females	All	(All female)
n	10	17	27	3
Age (years) mean (SD)	69.4 (5.7)	72.4 (6.0)	71.7 (6.5)	75.8 (11.3)
BMI mean (SD)	29.1 (3.2)	27.3 (4.4)	27.9 (4.1)	26.9 (2.3)
Marital status (%)				
Married/de facto	80	41	56	0
Single/widowed/divorced or separated	20	59	44	100
Education (%)				
High school (partial or completed)	30	53	44	33
Post-secondary (e.g., diploma)	40	35	38	66
Bachelor degree	20	6	11	0
Post-graduate	10	6	7	0
Income (AUD[a]) (%)				
Up to 20,799	10	12	11	0
20,800–31,199	10	24	19	33
31,200–41,599	10	6	7	0
41,600–72,799	30	6	15	33
72,800–129,999	30	6	15	0
Preferred not to answer	10	47	33	33
Paid employment				
% working in paid employment	20	12	15	0
Hours/week mean (SD)	15.5	7	11.3	0
Volunteer work				
% working as volunteers	60	53	56	33
Hours/week mean (SD)	6.3 (5.6)	4.6 (1.6)	5.3 (1.7)	0.7 (1.2)

[a] AUD: Australian Dollar (at the time of data collection, 1AUD was equal to approximately 0.84USD).

Table 2
Paired *t*-tests with sequential Bonferroni correction, and effect sizes (with 95% confidence intervals) for the activPAL inclinometer outcomes ($n = 27$).

Outcome	Pre-mean (SD)	Post-mean (SD)	Mean difference	p^*	Bonferroni-corrected alpha	Effect size (d)	95% confidence intervals	
							Lower	Upper
Total sitting time (min/day)	534.1 (114.1)	482.6 (112.0)	−51.5	**0.006**	0.013	−0.58	−0.02	−1.14
Sitting <30 (min/day)	234.1 (60.7)	236.6 (63.0)	+2.5	0.801	0.050	0.05	−0.49	0.59
Sitting ≥30 (min/day)	299.9 (118.3)	246.0 (105.1)	−53.9	**0.003**	0.008	−0.62	−1.18	−0.06
% of waking time sitting	57.4 (12.7)	52.1 (12.1)	−5.3	**0.004**	0.010	−0.60	−1.16	−0.04
No. of bouts sitting ≥30 min (n)	5.0 (1.9)	4.2 (1.7)	−0.8	**0.002**	0.007	−0.70	−1.26	−0.14
Standing (min/day)	291.7 (97.3)	330.2 (99.4)	+38.5	**0.006**	0.017	0.58	0.02	1.14
Stepping (min/day)	106.7 (48.2)	114.2 (43.3)	+9.3	0.148	0.025	0.35	−0.20	0.9

* p values <0.05 were considered statistically significant following sequential Bonferroni correction (shown in bold type).

Table 3
Paired *t*-tests with sequential Bonferroni correction, and effect sizes (with 95% confidence intervals) for the self-reported use of time recall data ($n = 27$).

Outcomes	Pre-mean (SD)	Post-mean (SD)	Mean difference	p^*	Bonferroni-corrected alpha value	Effect size (d)	95% confidence intervals	
							Lower	Upper
TST1.5[a] (min/day)	559.2 (137.4)	463.3 (127.3)	−95.9	**<0.001**	0.006	−0.77	−1.33	−0.21
TV (min/day)	192.3 (94.3)	160.1 (89.5)	−32.2	**0.005**	0.007	−0.59	−1.15	−0.03
Computer (min/day)	45.4 (65.6)	29.8 (37.3)	−15.6	0.25	0.017	−0.23	−0.78	0.32
Reading (min/day)	88.3 (74.3)	91.5 (73.2)	+3.1	0.818	0.050	0.04	−0.5	0.58
Passive transport (min/day)	43.1 (35.5)	39.5 (20.0)	−3.5	0.553	0.025	−0.11	−0.65	0.43
Light physical activity[b] (min/day)	214.8 (57.2)	256.6 (62.8)	+41.8	0.011	0.008	0.53	−0.02	1.08
Moderate-to-vigorous-physical activity[b] (min/day)	138.3 (75.0)	173.7 (83.8)	+35.4	0.024	0.010	0.46	−0.09	1.01
TDEE (MET min)	2197 (264)	2288 (251)	+91	0.037	0.013	0.42	−0.13	0.97

[a] TST1.5: Total sitting time accrued with activities rated as less than or equal to 1.5 METS.
[b] Light physical activity included activities eliciting 2.0–2.9 METs, and moderate-to-vigorous-physical-activity included moderate (3.0–5.9 METs) and vigorous (≥6.0 METS) activities.
* p values <0.05 were considered statistically significant following sequential Bonferroni correction (shown in bold type).

participants who completed the baseline assessment also completed the post-intervention assessment, resulting in a retention rate of 90%. In terms of time commitment, the face-to-face intervention appointment took approximately one and a half hours, including preparation of the individualized feedback on sedentary time, and the phone calls took approximately five minutes per participant, per week. All participants received, and participated in the weekly phone calls.

4. Discussion

This study aimed to evaluate the feasibility and preliminary effectiveness of the 'Small Steps' program. After completing the program, participants reduced their total sitting time, time spent sitting in and number of prolonged bouts, and time spent sitting while watching TV, and also spent more time standing. There were high levels of uptake, retention, and program satisfaction. The observed decrease of 52 min a day in objectively-measured sitting represented a medium effect size (0.58) which is considerably greater than reductions reported in a recent meta-analyses [10], and in previous studies with older adults, which had small effect sizes [11–13]. Interestingly, this reduction in total daily sitting time was achieved predominantly through participants reducing the time spent sitting in longer bouts (≥30 min). Compared with previous studies, we found a larger effect size for increased standing time (current study: 0.58; [13]: 0.15; [12]: 0.34), and similar or smaller effect size for increased stepping time (current study: 0.35; [13]: 0.39; [12]: 0.16). This suggests that, similar to the study by Rosenberg et al. [12], participants in our study mostly replaced sitting time with standing rather than stepping.

It is not clear what sort of reductions in sedentary time are needed to confer positive health benefits. A recent randomised controlled trial [23]; reported a significant intervention effect for increased standing and significant improvements in fasting insulin and waist circumference in favor of the intervention group despite a null intervention effect for sitting (16.2 min/day decrease in the intervention group and a 3.6 min/day increase in the control group). Furthermore, recent isotemporal substitution studies have reported significantly decreased cardio-metabolic risk biomarkers and all-cause mortality by replacing 30–60 min of daily sedentary time with light physical activity or 'non-exercise' chores such as housework [24–26]. It is plausible that interventions targeting sedentary time may have the most potential health benefit in older adults, or people with chronic conditions, e.g., people with cardiovascular disease who find it difficult to engage in moderate intensity physical activity. There is a clear need for future sedentary time reduction trials to assess health outcomes.

This study has several strengths: the use of self-report and objectively-measured sedentary time has allowed exploration of the context and types of activities; the exclusion of sleep and non-wear time ensures accurate sitting, standing and stepping time; and the sample was representative of older Australians (aged ≥60 years) in terms of income, education, and marital status [27]. The 'Small Steps' intervention implemented in this study was informed by constructs from self-determination theory [16], and incorporated features aimed at satisfying the participants' needs for competence, autonomy, and psychological relatedness. The positive participant feedback regarding these intervention features such as the usefulness of the workbook and daily checklist, face-to-face intervention and feedback on sitting time, choosing their own goals and the weekly supportive phone calls, were indicative of a well-designed

and informed intervention. Interestingly, we did not find a significant association between self-reported goal achievement and objectively-measured sedentary time. This could be due to the very high level of self-reported compliance with goals, with nearly 90% of participants reporting that they achieved either all or most of their goals, or the effect of the overall 'program' incorporating the workbook, education, and individualized feedback on sedentary time in addition to the goal setting.

Small Steps was designed for participants to incrementally make small changes to their daily routines and behaviors, and for this to build slowly over time. While the six-week program duration is a strength, we did not include a control condition or assess whether changes were maintained after the program. There is a clear need for larger scale randomised trials with longer term follow up, and attention-matched control groups to examine the effectiveness of sedentary time interventions in older adults, and whether behavior change can be maintained. Based on the results of this study ($d = -0.58$, 95% CI −0.02 to −1.14 objectively-measured total daily sitting time), we can recommend that a subsequent randomised controlled trial should recruit a total sample of 103 (2 tailed, alpha 0.05, 80% power). A further limitation of the current study is that data from the three participants who withdrew from the study were not included in the analysis. Finally, our significant findings must be considered with some caution due to the relatively small sample size, and large number of secondary outcomes explored in this study.

5. Conclusions

In conclusion, we found that Small Steps was feasible and highly acceptable to older Australians. In addition, our intervention demonstrated preliminary evidence of a high level of effectiveness in decreasing both total sitting time, and bouts of prolonged sitting when compared with previous interventions. A well designed and conducted randomised controlled trial is required to provide the level of evidence to further demonstrate effectiveness of the 'Small Steps' program to reduce sedentary time in older adults. Given our ageing population, and documented high levels of sedentary time, this intervention shows promise for behavioral modification and possible health benefits in older adults.

Conflict of interest

None.

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Author declarations

All authors participated in the conception of this study, interpretation of the results, and drafting and reviewing of the manuscript, and have seen and approved the final version.

Provenance and peer review

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.maturitas.2015.12.014.

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