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Citation of the final article:
Healy, Genevieve N., Eakin, Elizabeth G., Owen, Neville, LaMontagne, Anthony D., Moodie, Marj, Winkler, Elisabeth A. H., Fjeldsoe, Brianna S., Wiesner, Glen, Willenberg, Lisa and Dunstan, David W. 2016, A cluster randomized controlled trial to reduce office workers' sitting time: impact on activity outcomes*, Medicine & science in sports & exercise*, vol. 48, no. 9, pp. 1787-1797.

Medicine & Science in Sports & Exercise, Publish Ahead of Print
DOI: 10.1249/MSS.0000000000000972

A Cluster RCT to Reduce Office Workers' Sitting Time: Impact on Activity Outcomes

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This study is funded by an NHMRC project grant [#1002706], project funding from the Victorian Health Promotion Foundation's Creating Healthy Workplaces program and, by the Victorian Government's Operational Infrastructure Support Program. Healy is supported by an NHMRC [#108029] Career Development Fellowship and a Heart Foundation Postdoctoral Fellowship [PH 12B 7054]. Dunstan is supported by an Australian Research Council Future Fellowship [#FT100100918], a NHMRC Senior Research Fellowship [#1078360] and the Victorian Government's Operational Infrastructure Support Program. Owen is supported by a NHMRC Program Grant [#569940] and a Senior Principal Research Fellowship [NHMRC #1003960]. Eakin is supported by a NHMRC Senior Research Fellowship [#511001]. LaMontagne is supported by Centre grant funding from the Victorian Health Promotion Foundation (grant #2010-0509). Moodie is supported by a NHMRC Centre for Research Excellence grant [#1041020]. Winkler was supported by a NHMRC Centre for Research Excellence Grant on Sitting Time and Chronic Disease Prevention – Measurement, Mechanisms and Interventions [#1057608]. None of the funders had involvement in the data analysis, data interpretation, data collection, or writing of the paper.

CONFLICT OF INTEREST

The results of the present study do not constitute endorsement by ACSM. Ergotron Pty Ltd (www.ergotron.com) has previously provided workstations for formative research related to the topic. No further honoraria or imbursements were received. There are no other relationships or activities that could appear to have influenced the submitted work.

Short title: Reducing workplace sitting: a cluster RCT

ABSTRACT

Purpose: To evaluate, compared to usual practice, the initial and long-term effectiveness of a workplace intervention targeting reducing sitting on activity outcomes. **Methods:** Office worksites (≥1km apart) from a single organization in Victoria, Australia were cluster randomized to intervention (n=7) or control (n=7). Participants were 231 desk-based office workers (5 to 39 participants per worksite) working at least 0.6 full time equivalent. The workplace-delivered intervention addressed organizational, physical environment, and individual behavioural change to reduce sitting time. Assessments occurred at baseline, three-, and 12-months, with the primary outcome participants' objectively measured (activPAL3^{TM} device) workplace sitting time (mins/8-h workday). Secondary activity outcomes were: workplace time spent standing, stepping (light, moderate-vigorous and total) and in prolonged (≥30min) sitting bouts (h/8-h workday); usual duration of workplace sitting bouts; and, overall sitting, standing and stepping time (mins/16-h day). Analysis was by linear mixed models, accounting for repeated measures and clustering and adjusting for baseline values and potential confounders. **Results:** At baseline, on average, participants (68% women; mean±SD age = 45.6±9.4 years) sat, stood and stepped for 78.8±9.5%, 14.3±8.2%, and 6.9±2.9% of work hours respectively. Workplace sitting time was significantly reduced in the intervention group compared to the controls at three months (-99.1 [95% CI -116.3 to -81.8] min/8-h workday) and 12 months (-45.4 [-64.6 to -26.2] min/8-h workday). Significant intervention effects (all favoring intervention) were observed for standing, prolonged sitting, and usual sitting bout duration at work, as well as overall sitting and standing time, with no significant nor meaningful effects observed for stepping. **Conclusions:** This workplace-delivered multicomponent intervention was successful at reducing workplace and

overall daily sitting time in both the short- and long- term. **Key words:** workplace, cardio-metabolic biomarkers, accelerometry, sedentary, physical activity

INTRODUCTION

Too much sitting is now recognized as a public health concern (6). On average, sedentary time (sitting or reclining while awake with low energy expenditure)(33) occupies more than half of adults' waking hours (22), with this proportion expected to escalate (26). In office workers, workplace sitting is the largest contributor to daily sitting time (28). Further, much of this sitting time is accumulated in prolonged, unbroken bouts of 30 minutes or more (11, 14, 32) — a pattern that may entail greater cardio-metabolic risk than sitting for short periods at a time (8, 16). With office workers constituting the largest single occupational sector in the United States, and the proportion of industrial sectors that involves sedentary work increasing (39), the office workplace has been identified as a key setting in which to target reductions in prolonged sitting time (15).

Workplace-delivered interventions have the advantage of being able to address multiple influences on prolonged sitting behavior (27), including intrapersonal, interpersonal, policy, and environmental (physical and social) factors (4, 40). Several studies have now demonstrated the effectiveness, feasibility and acceptability of a range of strategies to reduce sitting time in the office workplace (23, 29, 35, 36, 38). Consistent with workplace health promotion frameworks (40), interventions that address multiple levels of influence (i.e., the environment, the organization, the individual) (14, 24) have tended to show greater reductions in sitting than single-component interventions, such as individual-based counselling (17), computer prompt software (11), and sit-stand workstations (24). However, recent reviews (21, 23, 35) have noted that many studies have methodological limitations, including non-randomized study designs, small sample sizes, short follow-up periods (typically three months or less) and/or poor control

for confounding (15, 23, 29, 35, 36, 38). To address these limitations, we examined the initial (3-month) and long-term (12-month) impact of a multi-component workplace intervention targeting reductions in workplace sitting on participants' activity outcomes.

METHODS

Stand Up Victoria was a 12-month cluster randomized controlled trial. Ethics approval was granted by Alfred Health Human Ethics Committee (Melbourne, Australia), with prospective trial registration with the Australian New Zealand Clinical Trials register (ACTRN12611000742976). The study was conducted in accordance with the CONSORT guidelines for cluster randomized controlled trials (http://www.consort-statement.org/). A detailed study protocol (9), including the properties of the measures used and description of the intervention development process (25) (including findings from the pilot study (14)) are available; brief details are provided below.

Setting and participants

The study was conducted in partnership with the Department of Human Services (DHS) — a large Australian Government organization with over 35,000 staff nationwide. Recruitment occurred between April 2012 and October 2013. Study sites were identified as potentially eligible by the DHS-appointed research liaison person if they were from geographically separate (≥1 kilometer apart) DHS buildings (sites) in the state of Victoria (metropolitan and regional) and were not currently delivering a physical activity program to staff. Within each site, a team (i.e., a distinct working group within the site that had a dedicated line manager and regular group meetings and interactions) was identified. Prior to randomization, written informed consent was

obtained from the divisional manager of each team for their employees to participate in the study; for the environmental component to be incorporated into the office workspace; and, for health coaching elements to be conducted during work time.

Following randomization, an information session about the study was presented for consenting teams within each site, with summary material also provided via email. Potential participants completed an expression of interest form either directly following the information session or via email afterward. Employees within these participating teams were initially considered eligible at the telephone screening if they worked at least 0.6 full time equivalent hours, were aged 18–65 years, were English-speaking, had designated access to a telephone, internet, and desk within the workplace, were not pregnant, were ambulatory, had no physical or health problems that may limit their ability to stand for at least 10 minutes at a time, and had no planned absence from work for over two weeks or a planned relocation to another workplace during the first three months of intervention (during implementation of the individual strategies). Potential participants also needed to have undergone baseline assessment and remain willing and eligible to take part by the time the intervention commenced to be considered eligible for the intervention. All participants provided written informed consent. Participants and study staff were unblinded to group allocation.

Assignment to study group

Randomization to either the intervention or control arms of the trial was at the level of the worksite via simple cluster randomization. This was achieved by generating a randomization plan for up to 24 clusters in one block (www.randomization.com) by a research staff member not

involved in recruitment or data collection. Participating sites were then randomly matched against the randomization plan using a list randomizer (www.random.org).

Control — usual practice

The control group underwent the same assessment protocol as the intervention group. Control participants received written feedback on their activity and biomarker outcomes at three months (baseline and three-month results provided) and 12 months.

Intervention

As previously described (9, 25), *Stand Up Victoria* was a multi-component intervention to reduce workplace sitting time. It was comprised of organizational-, environmental- and individual-level strategies and targeted change at both the individual and cluster level. Extensive formative research was used to guide intervention development (14, 25), which drew upon social cognitive theory and an ecological model of sedentary behavior (27). The intervention targets of "Stand Up, Sit Less, Move More" were informed by occupational health and safety guidelines (18), public health guidelines (3), as well as experimental evidence (8). These targets aimed to reduce sitting time — particularly sitting time accrued in prolonged unbroken bouts of at least 30 minutes — replacing it with either standing or stepping, and to do this across the whole day (both in and out of the workplace).

Organizational strategies: an initial consultation with senior management established the departmental resources available to support the program at an organizational level. Then, a three-hour group consultation workshop with representatives from each of the intervention sites

(managers, team champions, occupational health and safety representatives and general staff) was held to inform management and other organizational stakeholders about the study's broad aims and discuss the feasibility of the study from a management and team perspective. At this workshop, a range of organizational-level strategies appropriate for the various intervention sites were brainstormed. These strategies, as well as the baseline feedback, were then subsequently discussed with all participants at each intervention worksite to identify those strategies most suitable to their work context, with the site-specific strategies finalized using a participatory approach. Team champions (typically the worksite team leader) were recruited and encouraged to role-model and promote the organizational-level strategies. This included sending six emails, which the champion could tailor to include messages relevant for their team, at weeks 2, 4, 6, 8, 10, and 12. Research staff were copied in on the emails for monitoring of intervention fidelity.

Environmental strategies: a dual-screen sit-stand workstation (*Ergotron WorkFit-S;* www.ergotron.com), with a work surface accessory, was installed for the duration of the study (12 months). Participants received written and verbal instructions and tips on the appropriate ergonomic posture for both sitting and standing, as recommended by the product manufacturer (www.ergotron.com/tabid/305/language/en-AU/Default.aspx), as well as adhesive stickers applied by research staff to indicate the recommended configuration tailored for each individual (i.e., appropriate desk height when standing / sitting).

Individual strategies: were implemented over three months by study-trained health coaches. These consisted of an individual face-to-face coaching session (0–3 days following workstation installation) at the participants' workplace and four telephone calls at weeks 2, 4, 8 and 12. The

coaching was used to: explain the "Stand Up, Sit Less, Move More" intervention targets; indicate the extent to which participants were meeting these targets according to their baseline assessment results; and, to identify specific goals and individual-level behavior change strategies relating to each of these key intervention messages. Participants recorded their goals and strategies on their personal tracker (example provided in the protocol paper (9)), which was affixed to their workstation. During the face-to-face coaching session, participants also received specific instructions to "listen to their body," and to regularly change posture (i.e., to neither sit nor stand for too long). Following the consultation, a personalized email summary of the session was sent to participants. The telephone calls were used to support goal attainment. The calls involved assessment of participant progress toward previously set goals, problem-solving as necessary, and adjustment/progression of goals and related behavior change strategies. The telephone call at week eight focused on sitting and activity outside of the workplace. Intervention fidelity was maintained through the health coach's use of detailed intervention scripts and checklists and quarterly meetings with senior study investigators.

Data collection and measures

Assessments included activity monitoring, an onsite assessment, and an online questionnaire. They occurred at baseline, following three months of intervention (at completion of the tailored emails and individual-level health coaching) then at 12 months post baseline. Following the onsite assessment (which included the body composition measures and instructions on how to wear the activity monitor), participants were emailed a link to the self-administered online questionnaire (LimeService: www.limeservice.com), through which socio-demographic, work-

related, and other health-related data were collected. Demographic and work-related data were collected only at baseline.

Activity outcomes: Activity outcomes were: time per 8-hour day at work spent sitting, sitting for ≥30 minutes continuously (prolonged sitting), standing, stepping, stepping at a light (<3 metabolic equivalents; METs) intensity and stepping at a moderate-vigorous intensity (MVPA stepping; ≥3 METs), usual workplace sitting bout duration (min); and, overall time per 16-hour waking day spent sitting, standing and stepping. The primary outcome was workplace sitting time. The activity outcomes were measured by the highly accurate and responsive activPAL3^{TM} activity monitor (PAL Technologies Limited, Glasgow, UK; minimum version 6.3.0). The monitor was initialised, waterproofed and then secured onto the right anterior thigh with a hypoallergenic patch. Participants were asked to wear the monitor continuously (24 h/day) for seven days following the onsite assessment and to record daily in a diary their wake up, sleep ("lights out") and monitor removal times (if any). They were also asked to report their work hours, the location from which they worked, and periods spent in non-DHS paid employment (if any). Missing sleep/wake times were estimated from monitor movement data by study staff. For this manuscript, "sitting" is sitting/lying bouts recorded by the activPAL and "work" and "workplace" interchangeably refer to all DHS work from any location. At every assessment, almost all work time reported (≥98%) was for DHS, and very little (<5%) of the DHS work time reportedly occurred in locations other than primary DHS workplace.

Monitor data (activPAL events files) were processed in SAS 9.4 (SAS Institute Inc., Cary NC). Bouts that were mostly (≥50%) within the diary-reported times for waking hours, naps,

removals, and work hours were classed as such. Initially identified sleeping periods (not naps) were then adjusted to begin/end with the first/last sitting bout of ≥20 minute duration within the initial period. Only periods awake and wearing the monitor were examined. For each participant, time in each of the relevant activities while wearing the monitor was totalled for each day for all waking hours and all work hours. It was then averaged across valid workdays (monitor worn for ≥80% of work hours) and valid days (monitor worn for ≥80% of waking hours and for ≥10 hours when waking hours were inferred from movement). To account for variation in work or waking time wearing the monitor, time spent in each activity was normalised to an 8-hour workday or 16-hour waking day. For each individual, usual bout duration (also known as w50 or x50) for workplace sitting time was calculated across all relevant valid data using non-linear regression (Levenberg–Marquardt algorithm), fitting the cumulative distribution function for a power-law distribution (5). Each participant accumulates half of all workplace sitting time in bouts longer than his or her usual bout duration.

Adverse events: Data on adverse events related to the study (participant-reported) were recorded for the intervention group only via the online questionnaire (three and 12 months). Participants were asked if they had experienced any health problems that they believed were related to their participation in the study, and if yes, were asked to list the health problem(s); whether treatment was sought, and if so, from whom and how often (number of visits). Physical symptoms potentially attributable to the intervention that were mentioned as reasons for withdrawal from the study and/or sit-stand workstation component of the intervention were also counted as adverse events.

Potential confounders: At baseline, data on numerous participant characteristics were collected for consideration as potential confounders (see Table, Supplemental Digital Content 1, potential confounders adjusted for in models, http://links.lww.com/MSS/A700). Weight (nearest 0.1kg) was measured using foot-to-foot bioelectrical impedance analysis (BIA) scales (Model TISC-330S, Tanita Inc., Tokyo, Japan) in the fasted and voided state. Standing height was measured in duplicate to the nearest 0.1cm, with body mass index (BMI; kg/m^2) calculated using the average height and weight. Musculoskeletal health was assessed using the 27-item Nordic Musculoskeletal Questionnaire (7) over the last three months (instead of the usual 12 months) and last seven days. Problems were considered separately for the lower back, lower extremities and upper extremities, and if present were also categorized depending on whether the problem interfered with usual activities. Quality of Life was assessed as the physical and mental domains of the validated Australian Quality of Life Survey (AQoL-8D) (31). Job control and productivity were assessed using the Health and Work Questionnaire (34); an indicator of mental demands were derived from the Work Limitation Questionnaire (19). Dietary behaviors were assessed using the Fat & Fibre Behavior Questionnaire (30); measures of fatigue, headaches and sleep quality were also collected.

Sample size

Sample size details are reported elsewhere (9). Briefly, minimum differences of interest (MDI) for activity outcomes were 45 min/day of sitting, standing, and prolonged sitting; 15 min/day for all forms of stepping; and, 5 minutes for usual sitting bout duration. Based on prior pilot data, we expected 30% attrition and strong clustering for activity (Intracluster correlation, ρ=0.1), with an assumed average n per cluster () of 20 (Design effect = 2.9, estimated as) (10). We estimated

each arm required 160 participants spread across 8 clusters to achieve ≥90% power (5% two-tailed significance) to detect MDIs for activity outcomes.

Statistical analyses

Analyses were performed in STATA version 13 (STATACorp LP) with statistical significance set at $p<0.05$, two-tailed, and reporting any interactions at $p<0.1$. For continuous outcomes, intervention effects and changes within groups were estimated using linear mixed models. Outcomes were transformed (log transformations) as required to improve normality and/or reduce heteroscedasticity. Models included: fixed terms for group (intervention/control), time (3-/12- months) and the group by time interaction; baseline values of the outcome and potential confounders; and, random intercepts for workplace (REML estimation). The models used unstructured within-participant covariance to deal with the repeated measures (3- and 12-months). A list of all potential confounders was first identified *a priori* (Table, Supplemental Digital Content 1, potential confounders adjusted for in models, http://links.lww.com/MSS/A700) and those displaying an association with the outcome at $p<0.2$ in backwards elimination were included in models. Estimates of changes within groups, and differences between groups, were obtained using marginal means and pairwise comparisons of marginal means of either the outcome or predicted values of the outcome back-transformed to the original scale (for transformed outcomes). Overall results across both 3- and 12- months combined were presented only if intervention effects did not differ between these timepoints at $p<0.1$. Effects are only described as "small" if they are less than the MDI.

To evaluate the sensitivity of results to missing data assumptions, analyses were also performed using multiple imputation by chained equations. Imputation models (m=20 imputations) included all variables used in the analysis, a fixed effect for cluster (10), and any variables that showed an association with the odds of missing data at $p<0.2$ (Table, Supplemental Digital Content 2, odds of missing data, http://links.lww.com/MSS/A701). The degree of clustering (intra-cluster correlation, ρ) in each outcome variable at baseline (unadjusted) was assessed using random intercept models. For the primary outcome, workplace effects were reported as both ρ and Best Linear Unbiased Predictions (BLUPs), using separate models for the short-and long-term outcomes, with a random intercept for workplace and fixed effects for randomisation, baseline values and confounders. The significance of workplace effects were tested by comparing models with and without a random intercept.

RESULTS

Recruitment outcomes

Out of the 17 potential sites identified by the host organization liaison, 14 were approached (recruitment was limited to the project funding period) and 14 consented to randomization, with seven sites allocated to receive the intervention and seven to the control condition (Figure 1). Five of the sites could be considered large (>200 employees), six medium (50-200 employees), and three small (<50 employees). Four of the sites did predominantly telephone-based work (customer service tasks), seven non-telephone based work (administrative/clerical tasks), and three sites had a mix of telephone and non-telephone tasks (13). A total of 278 employees across the sites initially expressed interest in the study, with 231 participants (between five to 39 per site) ultimately enrolled and ascertained to be eligible upon completing baseline assessment.

Participant characteristics

The baseline characteristics of the participants (Table 1) in terms of age (24 to 65 years with n=70 (30.3%) aged 35 to <45 years and n=83 (35.9%) aged 45 to <55 years), sex (68.4% female), full-time working status (79.2%), and job role (79.2% as clerical, service or sales) was comparable to the broader DHS employee population. Nationally, the majority of DHS staff are female (72%), employed full time (70%) and in the age brackets of 35 to <45 years (30%) or 45 to <55 years (29%). In Victoria, 71% of DHS staff are employed in Australian public service bands 3 and 4 (general administrative and service positions) (2). Most participants (n=163, 70.6%) had a BMI in the overweight or obese categories (≥25 kg/m^2). On average, most work time was spent sitting (78.8±9.5%; 53% of which was accrued in prolonged bouts), with limited time spent standing (14.3±8.2%) or stepping (6.9±2.9%). The corresponding values for all waking hours were 64.6±8.4%, 24.6±6.8% and 10.8±3.1% respectively. Further details of participant characteristics by worksite are provided elsewhere (13).

The intra-cluster correlations (ρ) in baseline values of the outcomes are shown in SDC 3 (Table, Supplemental Digital Content 3, ICCs for worksite clustering at baseline, http://links.lww.com/MSS/A702). Here, ρ ranged from 0.021 (95% CI: <0.001 to 0.580) for sitting per 16-h day to 0.265 (0.116 to 0.497) for MVPA stepping per 8h-workday, with a mean of 0.151 (specifically, 0.181 for the workplace activity outcomes and 0.090 for the activities per 16-hour waking day). There was no significant difference between intervention and control groups in missing data from loss to follow-up, skipped assessments and/or missing items (Table, Supplemental Digital Content 2, odds of missing data, http://links.lww.com/MSS/A701). Over the 12-month intervention, 31 (13.4%) participants formally withdrew from the study (no

intervention, no assessment) or were otherwise lost to follow-up (n=16, 16.8% controls and n=15, 11.0% intervention) and 11 became ineligible (n=4, 4.2% controls, n=7, 5.1% intervention; Figure 1). Data on changes in workplace sitting (primary outcome) were obtained from 121 intervention and 87 control participants (89.0% versus 91.6%, p=0.656) in all 14 worksites (7 to 32 per intervention site and 5 to 32 per control site) at the 3-month follow-up, and from 97 intervention and 70 control participants (71.3% versus 73.7%, p=0.766) in all 14 worksites (5 to 27 per intervention site, 2 to 23 per control site) at the 12-month follow-up.

Intervention implementation

All worksites completed the initial (feedback and brainstorming) consultation, and all team champions complied with the tailored email protocol (6/6 emails sent). All intervention participants (n=136) received their face-to-face coaching session and the associated email from the health coach, and at least one telephone health coaching call with 77 participants (57%) receiving all four calls (41 received three calls, 12 received two calls, four received one call). The median (min, max) duration was 35 (25, 45) minutes for the face-to-face coaching session (n=136 sessions) and 8 (5, 12) minutes for the telephone coaching calls (n=459 calls).

Activity outcomes

Table 2 shows the results for changes within groups and for differences between intervention and control groups (intervention effects) for the activity outcomes, adjusted for baseline values and confounders. Significant intervention effects, favoring the intervention group, at one or both of the follow-up assessments, were observed for all of the activity outcomes except for stepping, light stepping and MVPA stepping (Table, Supplemental Digital Content 4, light and MVPA

stepping, http://links.lww.com/MSS/A703) for which no significant or meaningful intervention effects were observed. The intervention effects for sitting and standing, respectively, showed the intervention group sat less and stood more than controls (all $p<0.001$) by a large amount at the workplace, both at three months (-99.1 and +95.2 min/8-h day) and 12 months (-45.4 and +42.8 min/8-h day), and overall across the waking day at both three months (-77.7 and +75.8 min/16-h day) and at 12 months (-36.3 and +41.1 min/16-h day). At three months, participants sat for significantly shorter periods at a time than controls at work (-4.4 min), with the amount of prolonged sitting time at work being also lower (-72.6 min/8-h day). All of the significant intervention effects occurred through significant intervention group improvements that exceeded any control changes.

All of the significant intervention effects were also stronger at three months than at 12 months (all $p<0.001$). Mostly, significant intervention effects were seen for both initial and long term outcomes. The exceptions were prolonged sitting time and usual bout duration, for which only significant short-term intervention effects were seen. Here, although these outcomes remained improved over baseline within intervention participants, they also improved within controls between baseline and the 12-month assessment.

Substantial workplace variation was observed in baseline workplace sitting (ICC=0.201, 95% CI: 0.075 to 0.438, $p<0.001$). At three months, workplace variation (after adjusting for randomization condition, baseline values and confounders), was non-significant ($p=0.374$), weak ($\rho=0.010$, 95%CI: <0.001 to 0.899), and estimated with a wide margin of error. The BLUPs showed <5 min/8-h day differences for each worksite from the average (Figure 2). Workplace

variation for long-term change was significant (p=0.006) and strong (ρ= 0.175, 95% CI: 0.048 to 0.468). Accounting for randomization condition, baseline values and confounders, two sites (both receiving the intervention) differed significantly from the average, with one site doing significantly better (-62.0, 95% CI: -110.7 to -13.4; site M) and one significantly worse (43.6, 95% CI: 1.4 to 85.8 min/8-h, site K) than average.

Sensitivity analyses: The conclusions concerning intervention effects for the activity outcomes were unchanged in the multiple imputation (MI) analyses as per the completers analyses (Table, Supplemental Digital Content 5, multiple imputation analysis, http://links.lww.com/MSS/A704). The differences between MI and completers analysis estimates of intervention effects for activity outcomes were all less than five minutes with many (including those for stepping and usual bout duration) less than one minute.

Adverse events

Adverse events in the intervention group that may have arisen from study participation are reported in Table 3. A total of 29 intervention participants (21.3%) reported an adverse event(s) across the entire study, either in the questionnaire, as a withdrawal reason, or both. Of the 31 events reported in the questionnaire (from both 3- and 12-months), 26 were related to musculoskeletal problems in the upper body (n=16), back/lower back/bottom (n=4), or lower limb (n=6). Of the 23 participants who withdrew from the study, or from the sit-stand intervention component of the study (i.e. they asked for the workstation to be removed), 11 (48%) did so due to an adverse event they attributed to study participation (all musculoskeletal-related). A plausible mechanism for some of the adverse musculoskeletal events is via prolonged

static standing (37). Intervention group participants accumulated half of their workplace standing time in bouts longer than a median (minimum, maximum) of 1.4 (0.4, 12.9) minutes at baseline, 5.5 (0.7, 24.3) minutes at 3 months, and 3.6 (0.7, 19.3) minutes at 12 months. Though most standing occurred in short bouts, continuous periods of ≥30 minutes of standing were seen during the monitoring period in 5.1% (7/136) of intervention participants at baseline, in 48.8% (59/121) at three months, and in 29.9% (29/97) at 12 months.

DISCUSSION

The *Stand Up Victoria* study evaluated a multi-component intervention incorporating organizational-, environmental-, and individual-level change strategies aimed at reducing workplace sitting time in a cluster-randomized trial of 14 worksites of office workers from the one large organization. Significant reductions in both workplace and overall sitting time, exceeding any control improvements, were observed in both the short term (three months) and long term (12 months). These corresponded with approximately equivalent intervention effects for standing time, with small and non-significant effects for stepping. These novel findings suggest that a workplace-delivered intervention can elicit relatively large improvements in sitting time over a sustained period. Though issues of compensation and generalization (20) are yet to be examined in detail, we did not observe evidence that reducing sitting time and targeting primarily the workplace led to a detrimental intervention effect for the total time spent in other activities (standing, stepping) due to compensation.

The short-term intervention effect on workplace sitting (>1.5 hours per 8-hour workday) was comparable in magnitude to previous studies that have evaluated this type of

multicomponent intervention (14, 24), and with other interventions that have included an activity-permissive workstations component (23). Notably, the individual health coaching component of the intervention ceased after three months, as did support from the researcher team to promote organizational-level change via the tailored emails. Nevertheless, the long-term intervention effects were still large, at approximately 45 minutes per 8-hour workday or half an hour per 16-hour waking day on average. In line with the focus of the intervention, most of the intervention effects on workplace sitting, especially in the short term, occurred through reductions in sitting accrued in prolonged unbroken bouts. Consistent with previous studies that used this type of intervention approach (14, 24), sitting was primarily replaced with standing, suggesting that the sit-stand workstations were major contributors to behavior change. Collection of context specific data, such as through wireless technology, may be of benefit to understand where the changes are happening, and which strategies are being implemented.

The impact of this workplace-delivered intervention on overall sitting (both in and out of the workplace setting) was significant, substantial, and compared favorably against interventions that have been conducted outside of the workplace setting (1, 12). Our intervention targeted all sitting but focused on workplace behaviors primarily; adding further emphasis on settings outside the workplace might increase the reductions in overall sitting over what we achieved. Notably, the control group also improved in several workplace activity outcomes. These may have been random findings (multiple testing), observer effects, response to the feedback provided, or may reflect general trends within the workplace. Work teams from different buildings were chosen and randomized but we cannot be certain there was no interaction between teams or that the intervention messages did not disseminate through the organization.

During the course of the intervention, there was also significant media attention on the health risks of too much sitting, globally and particularly in Australia, and sedentary behavior public health guidelines that promote regularly breaking up prolonged sitting have emerged (3).

Adverse events plausibly attributable to the intervention were observed in approximately one-fifth of intervention participants during the 12 months of observation. Nearly all were related to musculoskeletal pain (primarily neck/shoulder pain) and participants attributed these to the use of the sit-stand workstation. Both job tasks and workstation design (retrofitted to the existing desk, up and down movement only) are likely to contribute to the symptoms observed. It may also be that additional training and/or information on workstation use may be required. Some of the other symptoms (lower limb, back) may relate to the manner in which standing was increased in long periods at a time. However, it is worth noting that musculoskeletal complaints were common in the sample: most participants had some form of musculoskeletal problem prior to the intervention and many had problems at a level that interfered with their daily activities. Collection of additional data on the level of pain may provide further insights into these symptoms and the extent to which they were exacerbated or relieved by the intervention. Employees, especially those with pre-existing musculoskeletal complaints, may need more than instructions on ergonomic positioning of the monitors when given a sit-stand workstation, such as condition-specific advice and instructions in pain-relief exercises.

Strengths of the study, which address several of the limitations noted in previous studies (21, 23, 35, 38), include the cluster randomized controlled design, evaluation of the short- and long-term effects of the intervention both at the workplace and overall, and the use of high-

quality objective measures of the activity outcomes. Though data on long-term change in the primary outcome (workplace sitting) was unavailable for approximately 30% of participants, there was very little evidence of bias, with multiple imputation analyses and completers' analyses showing near identical findings. Evaluating multiple work teams across different sites would offer more generalizable evidence than the single-site studies mostly evaluated to date; however, using multiple sites from one organization helps to control for organizational-level effects. Despite not using probabilistic recruitment methods, participants were fairly characteristic of staff within the organization in terms of age, gender, and full-time status. However, generalizability to other organizations and workers is limited as there was significant workplace variation, and only work teams and sites from a single organization (with fairly homogenous job tasks) were studied. Many potential confounders were considered, but residual confounding is still possible from unmeasured characteristics. Several key research questions remain to be addressed within this trial, including evaluation of: the intervention impact on health outcomes (including cardio-metabolic biomarkers); work outcomes (including productivity); when activity changes occurred; intervention acceptability (including qualitative data); cost-effectiveness; mediators and moderators of change (including worksite and team characteristics); and, long-term changes on policy and practice within the organization.

In conclusion, these primary outcome findings from the *Stand Up Victoria* intervention clearly demonstrate that large shifts in sitting time can be achieved with this multi-component approach, which included strong buy-in from the organization. Critically, the intervention elements, including tailoring, flexibility, and a participatory approach, were designed with

consideration for scale-up and wider dissemination. The challenge now is to understand the uptake, implementation and effectiveness when adapted for this next phase.

ACKNOWLEDGEMENTS

This study is funded by an NHMRC project grant [#1002706], project funding from the Victorian Health Promotion Foundation's Creating Healthy Workplaces program and, by the Victorian Government's Operational Infrastructure Support Program. Healy is supported by an NHMRC [#108029] Career Development Fellowship and a Heart Foundation Postdoctoral Fellowship [PH 12B 7054]. Dunstan is supported by an Australian Research Council Future Fellowship [#FT100100918], a NHMRC Senior Research Fellowship [#1078360] and the Victorian Government's Operational Infrastructure Support Program. Owen is supported by a NHMRC Program Grant [#569940] and a Senior Principal Research Fellowship [NHMRC #1003960]. Eakin is supported by a NHMRC Senior Research Fellowship [#511001]. LaMontagne is supported by Centre grant funding from the Victorian Health Promotion Foundation (grant #2010-0509). Moodie is supported by a NHMRC Centre for Research Excellence grant [#1041020]. Winkler was supported by a NHMRC Centre for Research Excellence Grant on Sitting Time and Chronic Disease Prevention – Measurement, Mechanisms and Interventions [#1057608]. None of the funders had involvement in the data analysis, data interpretation, data collection, or writing of the paper. We acknowledge and thank all the participants of the *Stand Up Victoria* study, as well as other staff involved at the Department of Human Services, particularly Tony Vane and Megan Evans. We also thank Peacock Bros for assisting with the logistics relating to the sit-stand workstations. We wish to thank Parneet Sethi for her assistance with data processing, Dr Takemi Sugiyama and Dr Sheleigh Lawler for their contribution to questionnaire development, Dr Maike Neuhaus for her assistance in the development of the intervention, and the following project field staff: Mary Sandilands, Kirsten Marks, Lisa Willenberg, Cameron Johnson, Beth Howard, Stephanie Fletcher and Michael

Wheeler. We also wish to acknowledge the assistance of the Department of Human Services liaison officers Sevasti Athiniotis and Valerie McRorie. The views expressed in this paper are those of the authors and not necessarily anyone in this acknowledgement list.

CONFLICT OF INTEREST

The results of the present study do not constitute endorsement by ACSM. Ergotron Pty Ltd (www.ergotron.com) has previously provided workstations for formative research related to the topic.(14) Dunstan presented at the 'JustStand Wellness Summit', a conference organised by Ergotron, in 2012 and Healy presented at the same summit in 2013. Ergotron covered travel and accommodation expenses for both Dunstan and Healy. No further honoraria or imbursements were received. There are no other relationships or activities that could appear to have influenced the submitted work.

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FIGURE CAPTIONS

Fig 1: Flow diagram of enrolment, participation, and analyses.

Figure 2: Worksite variation in short- and long- term changes in workplace sitting at intervention and control sites, adjusted for baseline values, randomisation condition and confounders. Data are BLUPs (95% CI) at three and 12 months with the order of the site letter (A to N) based on order of unadjusted total sitting time from BLUPs at baseline.

SUPPLEMENTAL DIGITAL CONTENT (SDC)

Supplemental Digital Content Table 1: Variables considered as potential confounders and adjusted in analyses

Supplemental Digital Content Table 2: Odds of missing data (logistic regression) in 136 intervention (Int) and 95 control (C) participants [a]

Supplemental Digital Content Table 3: ICCs (95% CI) for worksite clustering at baseline (n=14 clusters; n=231 Stand Up Victoria participants)

Supplemental Digital Content Table 4: Changes from baseline in mean workplace stepping, and differences between intervention and control groups, adjusting for confounders (completers analysis) [a]

Supplemental Digital Content Table 5: Changes from baseline in mean activity, and differences between intervention and control groups, adjusting for confounders (multiple imputation analysis)[a]

Figure 1

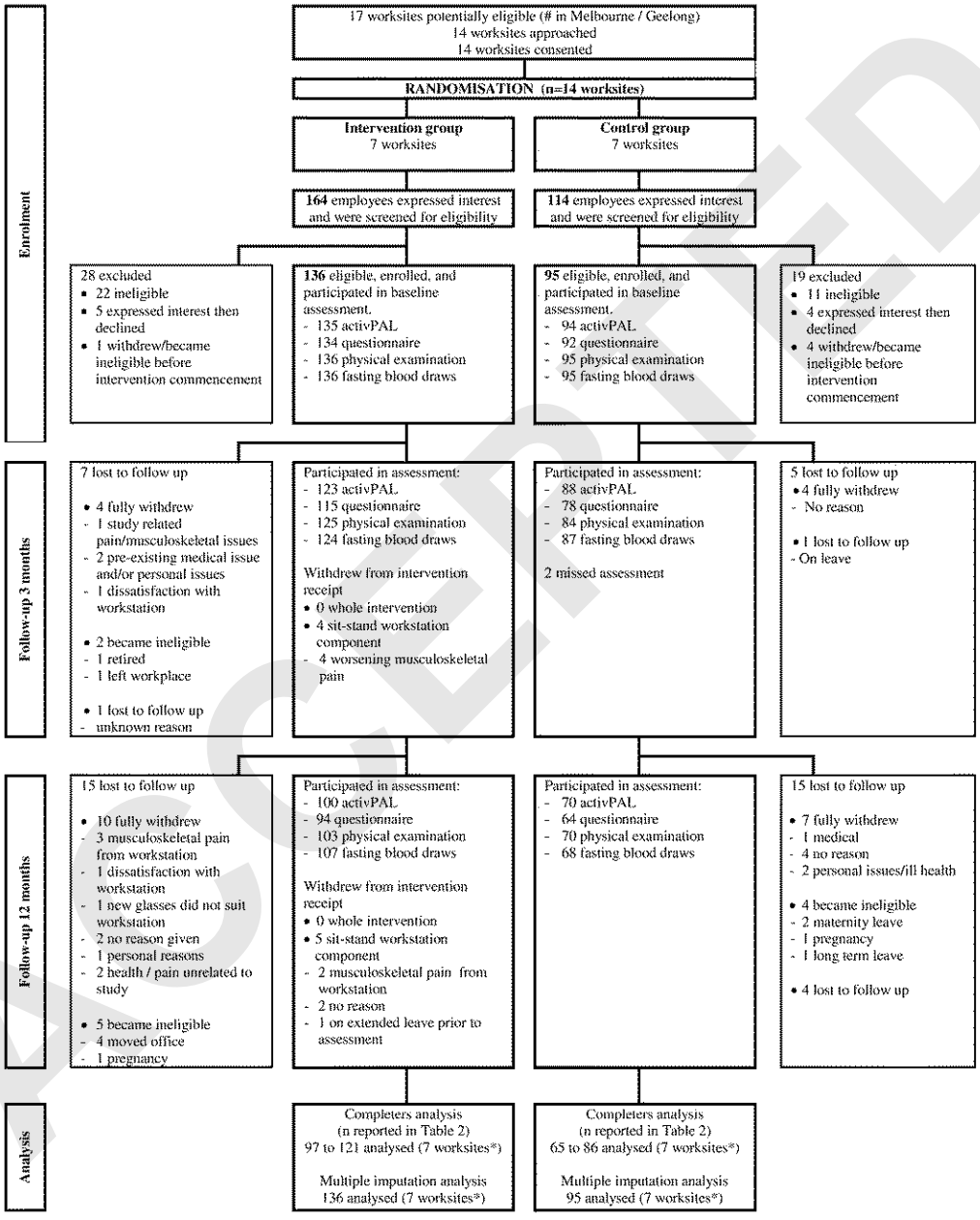

Figure 2

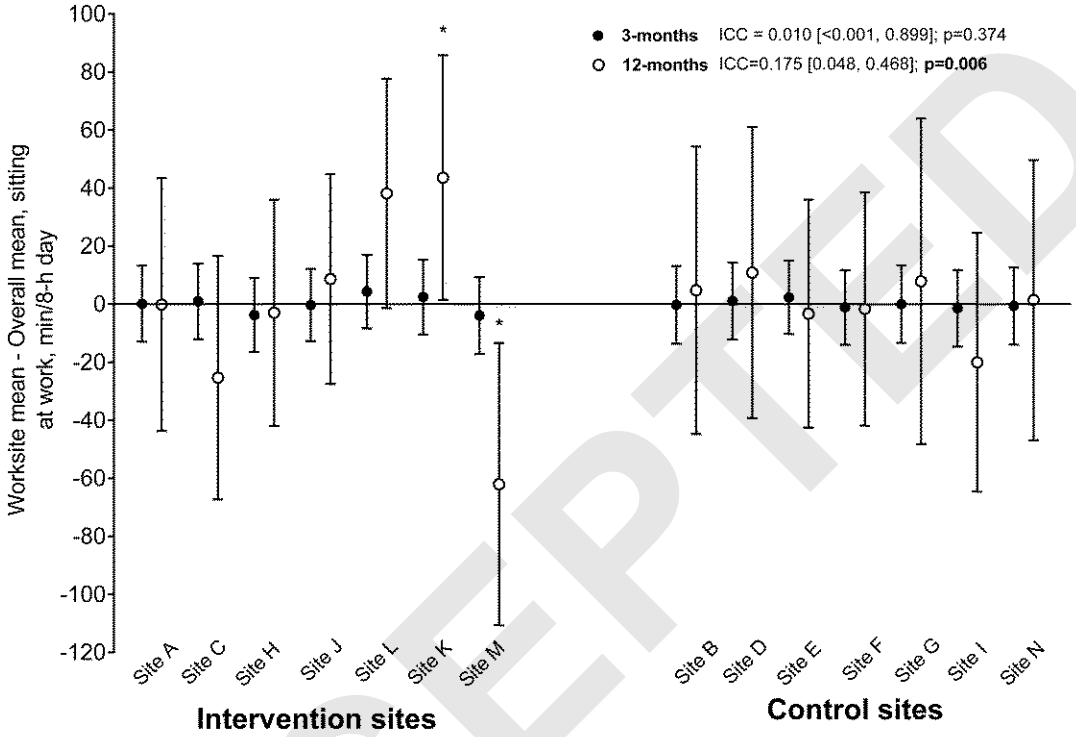

Table 1: Baseline characteristics of the *Stand Up Victoria* study participants (n=231, 14 teams), intervention (n=136, 7 teams) and control (n=95, 7 teams) groups

	Intervention (n=136, 7 teams)[a]	**Control (n=95, 7 teams)**[a]	**All (n=231, 14 teams)**[a]
Age, *years*	44.6 ± 9.1	47.0 ± 9.7	45.6 ± 9.4
Female	89 (65.4%)	69 (72.6%)	158 (68.4%)
Caucasian	109 (81.3%)	71 (77.2%)	180 (79.7%)
Married/living together	86 (64.2%)	62 (67.4%)	148 (65.5%)
Post-school education	90 (67.2%)	61 (66.3%)	151 (66.8%)
1.0 Full Time Equivalent, DHS	107 (79.9%)	72 (78.3%)	179 (79.2%)
Job category			
Manager/administrator	6 (4.5%)	10 (10.9%)	16 (7.1%)
Professional/associate	19 (14.2%)	12 (13%)	31 (13.7%)
Clerical / sales / service	109 (81.3%)	70 (76.1%)	179 (79.2%)
Current smoker	25 (18.7%)	17 (18.5%)	42 (18.6%)
BMI, kg/m^2	28.61 ± 6.46	28.61 ± 5.48	28.61 ± 6.08
Lower back problems [b]			
No	45 (33.6%)	28 (30.4%)	73 (32.3%)
Yes, does not affect activity	64 (47.8%)	49 (53.3%)	113 (50%)
Yes, affects activity	25 (18.7%)	15 (16.3%)	40 (17.7%)
Upper extremity problems [b]			
No	21 (15.7%)	15 (16.3%)	36 (15.9%)

Yes, does not affect activity		81 (60.5%)		63 (68.5%)		144 (63.7%)
Yes, affects activity		32 (23.9%)		14 (15.2%)		46 (20.4%)
Lower extremity problems [b]						
No		39 (29.1%)		30 (32.6%)		69 (30.5%)
Yes, does not affect activity		72 (53.7%)		46 (50%)		118 (52.2%)
Yes, affects activity		23 (17.2%)		16 (17.4%)		39 (17.3%)
Activity outcomes						
Workplace						
Sitting, *min/8-h*		381.1 ± 49.0		374.3 ± 39.9		378.3 ± 45.6
Standing, *min/8-h*		67.8 ± 44.1		70.1 ± 31.8		68.7 ± 39.5
Stepping, *min/8-h*		31.1 ± 13.8		35.6 ± 13.8		32.9 ± 14.0
Sitting in ≥30 min bouts, *min/8-h*		206.7 ± 95.5		195.9 ± 89.8		202.3 ± 93.4
Usual sitting bout duration, *min*		33.2 ± 14.9		31.8 ± 14.5		32.6 ± 14.8
Overall						
Sitting, *min/16h day*		625.2 ± 90		614.1 ± 64.4		620.6 ± 80.7
Standing, *min/16h day*		234.6 ± 74.7		237.9 ± 48.6		235.9 ± 65.3
Stepping, *min/16h day*		100.3 ± 31.1		108 ± 26.2		103.4 ± 29.4

Table presents n (%) or mean ±SD, with linearized variance estimation

[a] all n=136 intervention, n=95 controls (age and gender); n=134 intervention, n=92 controls (other questionnaire data); n=135 intervention, 94 controls (activity data)

[b] Problems in the lower back, upper extremities (neck, shoulders, elbows, wrists/hands) and lower extremities (hips, knees, ankles) were assessed over the "last three months" prior to baseline and were classed as no/yes/affects activity. No = no problem in last three months. Yes = problem in last three months but that does not interfere with daily activities. Affects activity = problem present that interferes with performing regular activities.

Table 2: Intervention effects (intervention - control) on changes from baseline in activity outcomes at the workplace and overall, adjusting for baseline values of the outcome and confounders (completers analysis) [a]

Outcome	Time	Intervention (n=136)		Control (n=95)		Intervention - Control		p
		n	Adjusted mean change (95% CI) [b]	n	Adjusted mean change (95% CI) [b]	Difference (95% CI) [c]	p	3M v12M
Workplace								
Sitting[d] , min/8h	3M	117	-107.8 (-122.5, -93.2)***	84	-8.8 (-17.6, 0.0)^	**-99.1 (-116.3, -81.8)**	**<0.001**	**<0.001**
Baseline = 387.3	12M	96	-58.3 (-72.9, -43.7)***	65	-13.0 (-25.3, -0.63)*	**-45.4 (-64.6, -26.2)**	**<0.001**	
Standing[d], min/8h	3M	119	102.2 (88.5, 115.9)***	85	7.0 (0.3, 13.7)*	**95.2 (79.8, 110.5)**	**<0.001**	**<0.001**
Baseline = 59.6	12M	97	55.2 (41.7, 68.8)***	67	12.4 (2.2, 22.7)*	**42.8 (25.8, 59.8)**	**<0.001**	
Stepping[d], min/8h	3M	117	2.2 (-0.8, 5.2)	83	1.7 (-1.4, 4.9)	0.5 (-3.9, 4.9)	0.829	0.674
Baseline = 30.3	12M	96	-0.3 (-3.3, 2.7)	65	-0.1 (-3.5, 3.3)	-0.2 (-4.8, 4.3)	0.926	
Sitting accumulation								
Sitting ≥30 min bouts, min/8h	3M	117	-88.8 (-102.5, -75.0)***	84	-16.2 (-32.2, -0.1)*	**-72.6 (-93.8, -51.4)**	**<0.001**	**<0.001**
Baseline = 204.2	12M	96	-50.1 (-68.1, -32.1)***	65	-32.3 (-53.9, -10.8)**	-17.7 (-45.8, 10.3)	0.216	

Usual bout duration	3M	120	-7.4 (-9.2, -5.6)***	85	-3.0 (-5.1, -1.0)**	**-4.4 (-7.0, -1.8)**	**0.001**	**<0.001**
Baseline=33.0	12M	96	-3.7 (-6.1, -1.4)**	67	-5.5 (-8.2, -2.8)***	1.7 (-1.8, 5.3)	0.329	
Overall								
Sitting, min/16h	3M	119	-77.9 (-92.5, -63.3)***	83	-0.2 (-17.3, 16.9)	**-77.7 (-100.3, -55.2)**	**<0.001**	**<0.001**
Baseline = 617.8	12M	97	-40.1 (-56.9, -23.2)***	65	-3.8 (-23.9, 16.4)	**-36.3 (-62.6, -10.0)**	**0.007**	
Standing, min/16h	3M	119	75.5 (63.6, 87.4)***	83	-0.3 (-14.5, 13.9)	**75.8 (57.1, 94.6)**	**<0.001**	**<0.001**
Baseline = 238.1	12M	97	46.1 (31.7, 60.4)***	65	4.9 (-12.5, 22.4)	**41.1 (18.3, 63.9)**	**<0.001**	
Stepping, min/16h	3M	121	1.5 (-3.7, 6.8)	86	0.6 (-5.3, 6.4)	1.0 (-6.9, 8.8)	0.810	**0.042**
Baseline = 103.9	12M	98	-6.6 (-12.0, -1.1)*	67	-0.6 (-6.7, 5.5)	-6.0 (-14.2, 2.2)	0.154	

^ p<0.1 (change from baseline) * p<0.05 change from baseline ** p<0.01 change from baseline *** p<0.001 change from baseline

[a] all adjusted means are estimated from marginal means, with baseline values of the outcome and all confounders set to the overall mean, with the means backtransformed to original units for transformed outcomes. [b] changes are estimated from marginal means for predicted mean – mean baseline value; differences between groups are estimated from marginal means at three months and 12 months. [c] estimated from pairwise comparisons and contrasts of marginal means at mean values of baseline levels and all covariates (at three months and at 12-months). [d] outcome modelled as log of outcome or as log of 480 for sitting; results in tables are presented back-transformed to original unit.

Table 3: Adverse events related to study participation reported by the intervention group.

Time	Intervention participants	Participants with adverse events	Specific adverse event reported in questionnaire	Treatment sought for adverse event	Withdrew due to an adverse event [a]
Baseline to 12 months	n=136 (baseline)	All: 29 (21.3%)	31 events reported in questionnaire • upper body: neck/shoulder/arm (11), wrist (4) • back/lower-back/bottom (4) • lower limb: leg/knee/thigh (4), ankle (1), varicose vein (1) • other: headache (1), eye strain/sore eyes (3), stress/tiredness (1).	76 visits to health provider	From study: 5 From intervention receipt only: 6
Baseline to three months	n=136 (baseline)	All: 12 (8.8%) Questionnaire: 114 No, 7 Yes (5.8% of	13 events (from 7 participants) reported in questionnaire • upper body: neck/shoulder (6), wrist (2) • lower-back/bottom (2) • lower limb: thigh (2), ankle (1)	Questionnaire: 117 No , 6 Yes (5.0% of responses)	From study: 1 From intervention receipt only: 4

		responses)		36 visits to health provider	
Three months to 12 months	n=129 (not already withdrawn from study/ lost to follow up / ineligible)	All: 17 (13.1%) Questionnaire: 82 NO, 11 YES (11.8% of responses)	18 events (from 11 participants) reported in questionnaire • upper body: neck/shoulder/arm (6), wrist (2) • back (2) • lower limb: leg/knee pain (2), varicose vein (1) • other: eye strain/sore eyes (3), headache (1), stress/tiredness (1)	Questionnaire: 88 No, 13 Yes (13.9% of responses) 40 visits to health provider	From study: 4 From intervention receipt only: 2

[a] adverse events potentially attributable to the intervention, all of which transpired to be musculoskeletal pain. Withdrawal from intervention receipt only = withdrawal from one or more intervention components while remaining in the study for assessments; in every case the intervention component the participant did not want to receive was the sit-stand workstation only.

Supplemental Digital Content Table 1: Variables considered as potential confounders and adjusted in analyses

Outcome	Models are adjusted for [a]
All outcomes	Baseline values of the outcome, age (years), gender (men/women) and the following if significant at p<0.2 (backward elimination): Physical Quality of Life (QoL) score, Mental Quality of Life (QoL) score, Total Fat & Fibre Behaviour Questionnaire (FFBQ) Index score, Fatigue score, Caucasian ethnicity (yes/no), married/living together (yes/no), completed post-school education (yes/no), currently smoke (yes/no), lower back problems (no/yes/affects activity)[b], upper extremity problems (no/yes/affects activity)[b], lower extremity problems (no/yes/affects activity)[b], weekly headaches (yes/no) weekly difficulties with sleeping or waking (yes/no), job control (high [6 to 10] / low [1 to 5]), productivity (high [≥ median of 7.4] /low [<7.4]), mental demands (high [≥median of 16.7]/low [<16.7]), Body Mass Index (BMI; kg/m^2) if p<0.2
Workplace activity outcomes	TV viewing time (h/week) if p<0.2
Workplace sitting (480-sitting), min/8h	Age, gender, physical QoL (log), mental QoL (log), BMI (log), TV viewing time (log), current smoking
Workplace prolonged sitting (log) , min/8h	Age, gender, physical QoL, log BMI, TV viewing time, weekly headaches
Workplace standing (log) , min/8h	Age, gender, BMI (log), TV viewing (log), current smoking
Workplace stepping (log), min/8h	Age, age squared, gender, physical QoL (log) , mental QoL (log), lower extremity problems, mental demands
Workplace light stepping (log) , min/8h	Age, gender, physical QoL (log) mental QoL (log), fatigue score (log), current smoking, productivity
Workplace MVPA stepping (log) , min/8h	Age, age squared, gender, physical QoL (log), lower extremity symptoms, weekly headaches, mental demands
Usual sitting bout duration at the workplace, min	Age, gender, FFBQ score
Overall sitting, min/16h	Age, gender, education, smoking, mental demands
Overall standing, min/16h	Age, gender, FFBQ score (linear and square term), post school education, lower back problems, lower extremity problems, mental demands

Overall stepping, min/16h	Age (linear and square term), gender, smoking

[a] Models adjusted for baseline values of the outcome, age and gender regardless of significance and other potential confounders (all baseline values only) that were retained as significant at $p<0.2$ in a backward elimination. Continuous independent variables were adjusted for as either a linear term, a linear and a square term or the log of the variable depending on the association with the outcome and the model checks.

[b] Problems in the lower back, upper extremities (neck, shoulders, elbows, wrists/hands) and lower extremities (hips, knees, ankles) were assessed over the "last three months" prior to baseline and were classed as no/yesd/affects activity. No = no problem in last three months. Yes = problem in last three months but that does not interfere with daily activities. Affects activity = problem present that interferes with performing regular activities.

Supplemental Digital Content Table 2: Odds of missing data (logistic regression) in 136 intervention (Int) and 95 control (C) participants [a]

	Activity models	
	OR (95% CI)	**p**
Missing (Int)	44 (33%)	
Missing (C)	31 (33%)	
Intervention group (Y/N)	0.99 (0.35, 2.75)	.979
Age (years)	1.01 (0.96, 1.06)	.603
Female (Y/N)	1.42 (0.77, 2.59)	.236
Physical QoL score	0.93 (0.63, 1.38)	.711
Mental QoL score	1.01 (0.57, 1.76)	.983
FFBQ score	1.25 (0.58, 2.73)	.542
Fatigue score	1.00 (0.93. 1.07)	.933
BMI (log), kg/m^2	2.06 (0.58, 7.33)	.239
TV viewing (log) h/day	0.77 (0.54, 1.11)	.146
Caucasian (Y/N)	0.50 (0.24, 1.05)	.065
Married/living together (Y/N)	1.11 (0.58, 2.13)	.727
Post school education (Y/N)	0.59 (0.28, 1.23)	.145
Currently smoke (Y/N)	2.44 (0.88, 6.76)	.082
Musculoskeletal		
Lower back		*.842*
No problem	1 (ref)	
Asymptomatic	0.90 (0.47, 1.70)	.719
Symptomatic	1.17 (0.48, 2.83)	.706
Upper extremities		*.585*
No problem	1 (ref)	
Asymptomatic	0.70 (0.29, 1.73)	.414
Symptomatic	0.94 (0.41, 2.18)	.883
Lower extremities		*.290*
No problem	1 (ref)	
Asymptomatic	1.45 (0.66, 3.20)	.326
Symptomatic	1.91 (0.82, 4.43)	.120
Weekly sleep problems (Y/N)	0.91 (0.39, 2.12)	.812
Weekly headaches (Y/N)	0.85 (0.27, 2.68)	.767
Sitting (log) h/16-h day	2.54 (0.28, 22.98)	.378
MVPA stepping (log) min/16-h	0.63 (0.20, 1.98)	.399
Job control (High/Low)	0.72 (0.33, 1.58)	.386
Productivity High/Low)	0.64 (0.36, 1.15)	.125
Mental demands High/Low)	**1.95 (1.04, 3.66)**	**.038**

Table presents odds ratio (OR) with 95% confidence interval (CI) and p-value from logistic regression. All yes/no (Y/N) variables compare yes versus no and high/low variables compare high versus low.

[a] Participants are considered to have missing data if data are missing for any of the outcomes at any timepoint, or for any of the covariates used in models for these outcomes.

Supplemental Digital Content Table 3: ICCs (95% CI) for worksite clustering at baseline (n=14 clusters; n=231 Stand Up Victoria participants)[a]

	ICC (95% CI)	n/cluster, mean (min, max)
Activity outcomes		
Sitting at work, min/8h day	0.201 (0.075, 0.438)	16.4 (5, 37)
Standing at work, min/8h day	0.128 (0.037, 0.364)	16.4 (5, 37)
Stepping at work, min/8h day	0.238 (0.100, 0.469)	16.4 (5, 37)
Light stepping at work, min/8h day	0.121 (0.033, 0.352)	16.4 (5, 37)
MVPA stepping at work, min/8h day	0.265 (0.116, 0.497)	16.4 (5, 37)
Usual sitting bout duration at work, min	0.135 (0.042, 0.355)	16.4 (5, 37)
Overall sitting, min/16h day	0.021 (<0.001, 0.580)	16.4 (5, 37)
Overall standing, min/16h day	0.128 (0.037, 0.364)	16.4 (5, 37)
Overall stepping, min/16h day	0.122 (0.035, 0.349)	16.4 (5, 37)

[a] calculated in STATA from random intercept models, REML estimation.

Supplemental Digital Content Table 4: Changes from baseline in mean workplace stepping, and differences between intervention and control groups, adjusting for confounders (completers analysis) [a]

Outcome	Time	Intervention (n=136)		Control (n=95)		Intervention - Control		p
		n	Change in mean (95% CI) [b]	n	Change in mean (95% CI) [b]	Difference (95% CI) [c]	p	3M v12M
Stepping[d], min/8h	All	120	1.1 (-1.7, 3.9)	84	0.9 (-2.1, 3.9)	0.2 (-4.0, 4.3)	0.940	0.674
Baseline = 30.3								
Light stepping[d], min/8h	3M	117	1.2 (0.5, 2.0)**	84	0.4 (-0.3, 1.1)	0.8 (-0.2, 1.8)	0.102	**0.032**
Baseline = 6.0	12M	96	0.5 (-0.2, 1.1)	65	0.4 (-0.3, 1.1)	0.1 (-0.9, 1.0)	0.916	
MVPA stepping[d], min/8h	3M	117	0.9 (-1.4, 3.2)	83	1.3 (-1.2, 3.8)	-0.4 (-3.8, 3.0)	0.834	
Baseline = 23.8	12M	96	-0.9 (-3.2, 1.5)	65	-0.5 (-3.2, 2.2)	-0.3 (-3.9, 3.3)	0.864	0.987
	All	120	0.1 (-2.0, 2.3)	84	0.5 (-1.9, 2.8)	-0.3 (-3.6, 2.9)	0.836	

^ p<0.1 (change from baseline) * p<0.05 change from baseline ** p<0.01 change from baseline

[a] all adjusted means are estimated from marginal means, with baseline values of the outcome and all confounders set to the overall mean, with the means backtransformed to original units for transformed outcomes.

[b] changes are estimated from marginal means for predicted mean – mean baseline value; differences between groups are estimated from marginal means at three months, 12 months and overall (i.e., across both 3- and 12- month follow ups combined)

[c] estimated from pairwise comparisons and contrasts of marginal means at mean values of baseline levels and all covariates (at 3-months, at 12-months and overall)

[d] outcome modelled as log of outcome; results in tables are presented back-transformed to original units

Supplemental Digital Content Table 5: Changes from baseline in mean activity, and differences between intervention and control groups, adjusting for confounders (multiple imputation analysis)[a]

Outcome	Time	Intervention (n=136)	Control (n=95)	Intervention – Control		p
		Change in mean (95% CI) [a]	Change in mean (95% CI) [a]	Difference (95% CI) [b]	p	3M vs 12M
Workplace						
Sitting[c] , min/8h	3M	**-105.6 (-123.8, -87.3)*** **	-8.0 (-18.7, 2.8)	**-97.6 (-119.0, -76.2)**	**<0.001**	
Baseline = 387.3	12M	**-59.4 (-77.5, -41.3)*** **	-12.6 (-27.9, 2.7)	**-46.8 (-69.9, -23.7)**	**<0.001**	**<0.001**
	All	**-80.9 (-97.7, -64.2)*** **	-10.2 (-22.0, 1.5)^	**-70.7 (-91.1, -50.3)**	**<0.001**	
Sitting ≥30 min bouts, min/8h	3M	**-85.8 (-101.5, -70.1)*** **	-14.8 (-33.0, 3.4)	**-71.0 (-94.9, -47.0)**	**<0.001**	**<0.001**
Baseline = 202.3	12M	**-48.2 (-69.5,-26.9)*** **	**-34.2 (-57.1, -11.3)****	-14.0 (-45.1, 17.0)	0.376	
	All	**-67.0 (-83.4, -50.7)*** **	**-24.5 (-42.7, -6.4)****	**-42.5 (-67.1, -17.9)**	**<0.001**	
Standing[c], min/8h	3M	**98.3 (82.9, 113.7)*** **	5.5 (-1.9, 12.8)	**92.8 (75.6, 110.0)**	**<0.001**	
Baseline = 59.9	12M	**53.7 (38.3, 69.1)*** **	**11.5 (0.5, 22.5)***	**42.2 (23.8, 60.6)**	**<0.001**	**<0.001**
	All	**74.1 (60.2, 88.1)*** **	**8.4 (0.4, 16.4)***	**65.7 (49.8, 81.6)**	**<0.001**	
Stepping[c], min/8h	3M	2.1 (-0.9, 5.2)	1.8 (-1.4, 5.0)	0.3 (-4.1, 4.7)	0.882	
Baseline = 30.0	12M	-0.0 (-3.1, 3.1)	0.3 (-3.3, 3.9)	-0.3 (-5.0, 4.4)	0.895	0.700
	All	1.0 (-1.9, 3.9)	1.0 (-2.1, 4.2)	-0.0 (-4.3, 4.3)	0.961	
Light stepping[c], min/8h	3M	**1.3 (0.5, 2.0)****	0.4 (-0.3, 1.0)	0.9 (-0.1, 1.9)	0.078	**0.022**
Baseline = 6.0	12M	0.5 (-0.2, 1.2)	0.5 (-0.3, 1.3)	0.0 (-1.0, 1.1)	0.983	
	All	**0.9 (0.2, 1.5)****	0.4 (-0.2, 1.1)	0.4 (-0.5, 1.4)	0.300	
MVPA stepping[c], min/8h	3M	0.9 (-1.5, 3.2)	1.3 (-1.3, 3.9)	-0.4 (-4.0, 3.1)	0.801	0.835
Baseline=23.5	12M	-0.6 (-3.1, 1.9)	-0.5 (-3.4, 2.4)	-0.1 (-3.9, 3.7)	0.948	
	All	0.1 (-2.2, 2.4)	0.4 (-2.1, 2.9)	-0.3 (-3.7, 3.1)	0.842	
Usual bout duration	3M	**-7.1 (-9.2, -5.1)*** **	**-2.5 (-4.8, -0.2)***	-4.6 (-7.7, -1.5)	**0.003**	**<0.001**
Baseline=32.6	12M	**-3.3 (-6.0, -0.6)***	**-5.7 (-8.9, -2.6)*** **	2.4 (-1.6, 6.5)	0.241	

	All	**-5.2 (-7.3, -3.1)*** **	**-4.1 (-6.4, -1.8)** **	-1.1 (-4.2, 2.0)	0.081	
Overall						
Sitting, min/16h	3M	**-79.6 (-98.8, -60.4)*** **	1.1 (-19.8, 22.0)	**-80.8 (-109.3, -52.2)**	**<0.001**	
Baseline = 620.6	12M	**-43.1 (-64.7, -21.5)*** **	-8.4 (-32.6, 15.9)	**-34.8 (-66.5, -3.1)**	**0.032**	**<0.001**
	All	**-61.4 (-80.2, -42.5)*** **	-3.6 (-24.2, -16.9)	**-57.8 (-85.3, -30.2)**	**<0.001**	
Standing, min/16h	3M	**77.1 (59.7, 94.4)*** **	-0.3 (-19.4, 18.9)	**77.3 (51.2, 103.4)**	**<0.001**	
Baseline = 236.0	12M	**46.4 (26.2, 66.6)*** **	9.1 (-13.8, 32.0)	**37.3 (7.4, 67.3)**	**0.015**	**<0.001**
	All	**61.7 (44.2, 79.4)*** **	4.4 (-14.9, 23.7)	**57.3 (31.5, 83.2)**	**<0.001**	
Stepping, min/16h	3M	1.8 (-3.8, 7.3)	0.5 (-5.7, 6.6)	1.3 (-7.0, 9.6)	0.763	
Baseline = 103.4	12M	**-6.6 (-12.5, -0.6)***	0.6 (-6.2, 7.4)	-7.2 (-16.2, 1.8)	0.118	**0.017**
	All	-2.4 (-7.7, 2.9)	0.6 (-5.4, 6.5)	-2.9 (-10.9, 5.0)	0.497	

^ p<0.1 (change from baseline) * p<0.05 change from baseline ** p<0.01 change from baseline *** p<0.001 change from baseline

[a] all differences between groups and changes over time are estimated as adjusted means, estimated from MI marginal means, with baseline values of the outcome and all confounders set to the overall mean, with the means backtransformed to original units for transformed outcomes. Changes are estimated from marginal means for predicted mean – mean baseline value; differences between groups are estimated from marginal means at three months, 12 months and overall (i.e., across both 3- and 12- month follow-ups combined) from models including a group x timepoint (3M/12M interaction)

[b] mean difference, 95% CI estimated from pairwise comparisons of marginal means at mean values of baseline levels and all covariates (at 3-months, at 12-months and overall) all derived from models including a group x timepoint (3M/12M) interaction; p-value from coefficient for group (for 3M, with interaction group x timepoint (3M/12M) with 3M = referent; for 12M, with interaction group x timepoint (3M/12M) with 12M = referent; for overall, omitting the group x timepoint interaction)

[c] outcome modelled as log of outcome or as log of 480 for workplace sitting; results in tables are presented back-transformed to original units