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Published in:
Journal of Occupational and Environmental Medicine

DOI:
[10.1097/JOM.0000000000001389](https://doi.org/10.1097/JOM.0000000000001389)

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Recommended citation(APA):
Olsen, H. M., Brown, W. J., Kolbe-Alexander, T., & Burton, N. W. (2018). A brief self-directed intervention to reduce office employees' sedentary behavior in a flexible workplace. *Journal of Occupational and Environmental Medicine*, 60(10), 954-959. <https://doi.org/10.1097/JOM.0000000000001389>

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A brief self-directed intervention to reduce office employees' sedentary behaviour in a flexible workplace

Running title:

SELF-DIRECTED SITTING INTERVENTION FLEXIBLE WORK

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Funding: None declared

Conflicts of interest: None declared

Abstract

Objective: To assess changes in employees' sedentary behaviour following a brief self-directed intervention in a flexible workplace.

Methods: 30 employees (69% female; 39.5±9 years) completed an online questionnaire before and after a six-week intervention. The intervention comprised one group-based action planning session, using a smart activity tracker for self-monitoring, weekly email reminders and a healthy living seminar.

Results: Total self-reported sitting time (including occupational and non-occupational sitting) decreased non-significantly on days when working at the office ($M\Delta = -56\text{mins/day}$, 95% CI -128.5, 17.0) and increased non-significantly when working at home ($M\Delta = 20.5\text{mins/day}$, 95%CI -64.5, 105.5). The program had high acceptability in this participant group.

Conclusions: Brief self-directed interventions using activity tracker devices show promise and may be highly acceptable in a flexible workplace. Additional strategies may be needed to create change in sedentary behaviour.

Keywords: Flexible work, physical activity, sedentary behaviour, sitting, workplace, office workers, intervention

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Introduction

The workplace is a key contributor to the total time that individuals spend in sedentary behaviour, particularly in white-collar occupations. Studies have shown that office workers are more sedentary on work days than on non-work days, and that up to 81% of work time is spent in sedentary behaviour (1, 2). Occupational sitting has been positively associated with obesity and common workplace injuries such as back and neck pain (3-5). This may lead to increased financial costs to organisations, as overweight and obese employees have increased rates of absenteeism and productivity loss at the workplace (6-8). High levels of sedentary behaviour are also positively associated with metabolic risk factors and cardiovascular disease (9-11). Furthermore, there is emerging evidence that sedentary behaviour is inversely associated with positive mood and wellbeing (12, 13). Given the high levels of sedentary behaviour in office workers and the significant potential adverse outcomes, there is a strong rationale for the workplace as a prime intervention setting for health promotion targeting sedentary behaviour.

Traditionally, workplace health promotion interventions have focused on the workplace as a static environment with strategies attached to a physical location. However, large-scale advancement in technology has facilitated a fundamental shift in where and how work is performed (14). This changing work environment enables flexible working conditions that allow employees to adjust work schedules and work 'remotely' in different locations. Around a quarter (24.1%) of employees report completing at least some work at home (average 3 hours per day) on a regular basis (15). Contemporary workplace health promotion programs need to consider this shift to flexible work arrangements when planning and implementing interventions. Employees are in the workplace at varying times and strategies must be accessible to participants regardless of location.

Successful workplace health promotion programs tend to include the involvement of employees in the research process and deliver interventions that are tailored to the work group (16, 17). The most promising behaviour change strategies for sedentary behaviour interventions are self-monitoring, problem solving and restructuring the physical or social environment (18). These principles and strategies provide a useful framework for designing sedentary behaviour interventions in flexible workplaces.

Activity trackers are an easily accessible device for self-monitoring activity patterns (19). Activity trackers (e.g. Fitbit, Jawbone, Garmin), or 'wearable technology' typically allow the user to track movement patterns relating to physical activity, sedentary time and sleep. These devices have been shown to be effective in physical activity interventions (20-22). Trackers also support self-monitoring through real-time feedback and behavioural prompts. Some devices include features such as an idle alert which prompts the user to move after a pre-determined period of inactivity (19). Studies have shown that prompts through digital technology, such as smart-phone applications, are effective in reducing sitting time in adults (23, 24). This would suggest

that activity trackers with electronic behaviour prompts may be an appropriate tool in sedentary behaviour interventions in a flexible workplace, as the devices are not connected with the physical worksite.

Problem solving techniques are a natural complement to self-monitoring for behavioural change. Problem solving involves identifying barriers to behavioural change and the tools and resources that can assist individuals to overcome these barriers. Barriers can include cognitive, emotional, physical, social and/or environmental factors, as well as competing goals. Problem solving is closely related to action planning, which involves detailed consideration of what the person will do (which in turn relates to goal setting) contingent to a specific situation (25). Action planning and goal setting, as well as information sessions, are common strategies in workplace sedentary behaviour interventions. These strategies have been shown to be effective in reducing sedentary behaviour when used in conjunction with other strategies, such as an environmental change or electronic prompts (26-28).

Environmental changes in sedentary behaviour interventions in the workplace tend to focus on restructuring the physical environment (29, 30). Typically, these interventions have provided equipment such as a sit-to-stand workstation, in combination with other behaviour change strategies (e.g. goal setting, motivational interviewing). Whilst these types of interventions have been effective in reducing sedentary time (29-31), these may not be appropriate in a flexible workplace where it may not be feasible to modify workstations across multiple locations, including employee residences.

Targeting the social environment may be more feasible in a flexible workplace. Social support is positively associated with participation in workplace health activities (32), and social strategies can increase physical activity in workers (33, 34). Some of the social strategies that have been shown to be effective for physical activity behaviour change are buddy systems, and instructor-led activities with personal follow-ups (33). Virtual social connections and electronic communication may suit flexible workplaces, with options such as online resources, social media platforms and phone applications (e.g. smart tracker apps). A qualitative study on employee preferences for workplace health promotion indicated that social connections are especially important in a flexible workplace, as these relationships may potentially be comprised due to dispersed work locations (35).

The primary aim of this exploratory study was to assess change in office employees' sedentary behaviour following a brief self-directed intervention in a flexible workplace. The intervention included behaviour change strategies of problem solving and action planning, self-monitoring, and social support. The secondary aims were to assess the acceptability of the intervention and change in employees' physical activity.

Method

Study Design & Recruitment

This study used a single group pre-post design. Participants were employees from two business units (N=113 employees) at a financial services organisation based in Brisbane, Australia. The organisation had implemented a flexible work policy in the preceding twelve months that allowed employees to self-manage working hours and to work from home on one or more days per week.

During recruitment, multiple information sessions were held at the workplace to present the study aim and requirements. All staff received an email invitation which included a link to complete online consent and registration for the study. Registration included one screening question to identify whether individuals had access to a smart phone or tablet that was compatible with the activity tracker (Jawbone) technology. People who did not have access to a compatible device were ineligible for the study (N=2).

Participants completed assessments one week prior to the intervention (pre) and again at the completion of the six-week intervention (post). Participants were allowed to complete the online survey during normal working hours and no incentives for participation were offered. Study protocols were approved in accordance with the ethical review guidelines and processes of The University of Queensland Human Research Ethics Committee.

Intervention

The intervention was developed using formative research with the participating workplace (35). The key behaviour change techniques focused on self-monitoring, problem solving and social support. These are consistent with the social cognitive constructs of self-regulation, facilitation and the environment (36). The social cognitive framework is a useful tool for developing interventions as it provides principles and mechanism that can inform, guide and motivate people through behavioural change (37). The intervention strategies comprised: one group session for problem solving, goal setting, and action planning; provision of an activity tracker for self-monitoring and social support; weekly reminder emails and a healthy living seminar.

Participants attended an initial onsite group action planning session (90 minutes duration) during work hours. Three sessions were held at different times and days to accommodate flexible working arrangements. At this session, participants received verbal and written information on the national sedentary behaviour guidelines (38) and an overview of the current evidence of risks associated with prolonged sitting (9, 11, 39). After facilitated small group discussions, each participant developed a personalised action plan for the 6-week period, which included setting goals and actions for reducing sitting time, identifying potential barriers to achieve the change and strategies to overcome the identified barriers.

At the end of the session, participants received a Jawbone smart tracker device and were provided with information on features for self-monitoring and social connectedness that could be accessed using the associated app (e.g. idle alert, compatible apps). The Jawbone is a wrist-worn device that tracks time spent in idle activity (with vibration to alert the user to a period of inactivity). It allows tracking of steps and distance taken, energy expenditure, and additional information such as sleep, nutrition and exercise workouts. The device also includes a social network component available through the app. This allows users to set up their own online teams (and friends). Users can then choose to share part or all of their data with the team, see results and progress towards individual goals for team members, and comment on these results.

Weekly emails with links to sedentary behaviour change resources were sent to all participants. The purpose of these emails was to act as a reminder of the program and to provide links to existing organisational resources. These resources included a workstation ergonomic setup tip sheet, examples of stretches that can be completed at a workstation (neck, shoulders, arms, back and legs) and tips to be active (e.g. stand up while waiting on hold on the telephone, make a deal with a colleague to prompt each other to get up from the desk).

Participants were also invited to attend a healthy living seminar during week 4 of the intervention. This was intended as another reminder of the ongoing program, and to provide another forum for social connections. By popular request, this focussed on the impact of sedentary behaviour on back pain. The session was delivered by one of the researchers (TKA) who has expertise in exercise physiology and public health. The seminar was delivered at the worksite (60 minutes duration). Two sessions were held at differing times and days to accommodate flexible working arrangements. The session included information on physiology, pain management and techniques to reduce sitting time at work.

Measures

Sedentary Behaviour

Sedentary behaviour was assessed using the Workforce Sitting Questionnaire (40). Participants were asked to report sitting time (hours and minutes) in five domains (work, travel, television, electronic device use for leisure, and other leisure). An adapted version of the questionnaire was used with items split to ask about sitting time on each of a usual work at home day and a usual work at the office day. The original questionnaire has high test-retest reliability for weekday sitting at work, watching television and computer use ($r=0.84-0.78$ and acceptable validity against accelerometer data (40, 41). Sitting time was measured across all domains to capture potential displacement of sitting time as participants self-managed their flexible work patterns (e.g. sitting for travel may reduce, or sitting for leisure may increase, as participants work from home). Results focus on *overall* sitting time (occupational and non-occupational) and *occupational* sitting time, for each of a usual day working at home and a usual day working at the office.

Accelerometers (Actigraph GT3X+) were used to objectively measure sedentary behaviour. These devices have been shown to be reliable for measuring sedentary behaviour (42). Participants were asked to wear the accelerometer on a waist belt for 24 hours per day for seven consecutive days. Participants were also asked to record any time they removed the accelerometer (e.g. shower, sleep) and whether they were working from home, working from work or if it was a non-work day in a log sheet.

Physical Activity

Self-reported time spent in physical activity was assessed using items from the Active Australia survey (43). An adapted version of the questionnaire was used, with separate items to assess walking to get to or from places and walking for recreation. Participants reported the total number of sessions (frequency) and total time (duration) spent walking for recreation or exercise for at least 10 minutes at a time, walking to get to or from places for at least 10 minutes at a time, vigorous gardening or heavy work around the yard which made you breathe harder or puff and pant, vigorous physical activity (e.g. jogging, cycling, aerobics), and other moderate intensity activities (e.g. gentle swimming, social tennis) during the past week. Reliability coefficients for each domain of physical activity range from 0.56–0.64, and correlations between self-reported physical activity and objectively measured activity are 0.43 and 0.52 for pedometer and accelerometer data respectively (44). Physical activity was also assessed objectively using the data from the Accelerometers (Actigraph GT3X+).

Participant characteristics Participants were asked to complete a brief questionnaire with items about gender, age, living situation/ marital status, general health, height and weight. Work specific questions included years of service and mode of transportation to work.

Acceptability: In the post intervention questionnaire, participants were asked to rate their agreement/disagreement with six statements using a 5-point Likert scale. Items asked about overall satisfaction with the program, program suitability for a flexible work environment, usefulness of the tracker for changing behaviour and usefulness of the tracker features.

Data management

Sedentary Behaviour: Total self-reported time spent sitting was calculated as the sum of daily time spent in each domain (work, travel, television, electronic device use for leisure, and other leisure). Data were grouped by usual day working at home and usual day working at the office.

Extreme values by domain were determined as: >180mins/day for travel, >720mins/day for work, and >480mins/day for the leisure related domains (television, electronic device use for leisure, other leisure). Extreme baseline (pre) domain values were imputed with the sample mean. Extreme post-intervention domain values were recoded with the case pre-value to allow

for a conservative 'no change' between time points. Extreme values for overall sitting time (>960mins/day) were then truncated to 960mins/day.

Extreme values were identified on work at the office days for travel (n=1) and on work at home days for travel (n=1) and electronic device use for leisure (n=2). Extreme overall sitting time was identified on work at the office days (n=2) and work at home days (n=3). If usual hours working at home were reported as 0 at post-test, then sitting time on a work at home day was adjusted to a null value for all domains (n=5). If usual hours working in the office was reported >0 and sitting time in the work domain on a work at the office day was reported as 0, then the domain value was recoded with the sample mean (n=1).

Accelerometer data were included if the monitor was worn for a minimum of 600 minutes per day over at least three (3) days. Non-wear time (determined as more than 60 minutes of consecutive zeros) was excluded from analyses (45). Time spent in sedentary, light, moderate and vigorous activity was determined using the Troiano et al. (46) cut-points, through the Actilife data analysis software.

Physical Activity: Overall self-reported time spent in physical activity was determined as the sum of time (mins/week) spent in moderate, walking (both transport and exercise/recreation) and vigorous activity (excluding gardening), with vigorous activity time weighted by a factor of two (2) to reflect its higher intensity (43).

Extreme values were determined, a priori, as >840mins/week for a single activity type and >1680 weighted mins/week for overall time spent in physical activity. No extreme values were identified.

As all fields were mandatory in the online survey, there were no missing data.

Statistical Analyses

Mean change (95% CI) was used to assess change in self-reported time spent sitting on a usual work at home day and usual work at the office day, accelerometer minutes per day by activity category and self-reported physical activity for the past week. Analyses were completed using SPSS v24.

Results

Participant recruitment

An overview of participant recruitment is included in Figure 1. Thirty employees (26.5% of invited participants) completed the study. Just less than two thirds (61%) of baseline participants completed post-intervention assessments. Reasons for not completing full assessments were

provided voluntarily to the researcher and included unplanned leave, leaving the department and withdrawal from the study (N=19).

Insert Figure 1 about here

Participant characteristics

Mean age of the 30 participants was 39.5±9 years, 69% were female and 85% had been employed with the organisation for more than 2 years. Participant characteristics are shown in Table 1.

Insert Table 1 about here

Sedentary Behaviour

Self-reported sitting times in each domain on work days are presented in Table 2.

Total sitting time (including occupational and non-occupational sitting) on a usual day when working at the office decreased non-significantly by 56 minutes (95% CI -128.5, 17) from baseline to post- intervention. At an individual level, 14 participants (47%) decreased overall sitting time when working at the office by at least 30 minutes per day and among these, the average decrease was 206 minutes per day. Twelve participants (40%) decreased overall sitting time by at least 60 minutes per day when working at the office, with an average decrease among this group of 234 minutes per day.

Total sitting time on a usual day when working at home increased non-significantly by 20.5 minutes (95% CI -64.5, 105.5) per day. At an individual level, 12 participants (40%) decreased overall sitting time when working at home by at least 30 minutes per day, and among these, the average decrease was 136 minutes per day. Eight participants (27%) decreased overall sitting time when working at home by at least 60 minutes per day with an average decrease among this group of 199 minutes per day. Individual change plots are available in Supplemental Digital Content 1, <http://links.lww.com/JOM/A463>.

Insert Table 2 about here

Sitting time for work decreased non-significantly by 21 minutes (95% CI -71, 82) per day from baseline to post- intervention on days when working at the office. At an individual level, 11

participants (37%) decreased overall work-related sitting time at the office by at least 30 minutes per day and among these, the average decrease was 151 minutes per day. Ten participants (33%) decreased overall sitting for work when working at the office by at least 60 minutes per day, with an average decrease among this group of 163 minutes per day.

Sitting time for work decreased non-significantly by 12 minutes (95% CI -83, 60) per day from baseline to post- intervention on days when working at home. At an individual level, 13 participants (43%) decreased overall work-related sitting time when working at home by at least 30 minutes per day and among these, the average decrease was 145 minutes per day. Nine participants (30%) decreased overall sitting for work when working at home by at least 60 minutes per day with an average decrease among this group of 197 minutes per day. Individual change plots by domain are available in Supplemental Digital Content 2, <http://links.lww.com/JOM/A464>.

Insert Table 3 about here

Accelerometer data indicated no change in in sedentary levels from baseline to post-intervention (see Table 3).

Overall self-reported time spent in physical activity increased non-significantly after the intervention ($M\Delta = 19$ mins per week, 95% CI -177, 139).

Intervention acceptability

This program had high acceptability with this participant group (see Table 4). The majority (90%) of participants reported that they were satisfied or very satisfied with the program. Participants agreed/strongly agreed that the intervention was suitable for a flexible work environment (95%), that they liked to be able to monitor their own behaviour (89%), and that the tracker was a useful tool for helping to change behaviour (83%). The following features of the activity tracker were identified as most useful by participants: step count, % activity target, idle alert, summary pages (charts), and the following features were least useful: calorie tracking, workout log, food log, associated apps, goals.

Insert Table 4 about here

Discussion

This study assessed change in employees' sedentary behaviour following a brief self-directed intervention using a smart tracker in a flexible workplace. Analyses indicated a non-significant reduction in self-reported total time and work-related time spent sitting on a usual day working from the office, and in work-related sitting time on a usual day working from home. There was also a non-significant increase in self-reported total time spent sitting on a usual day working at home. The program had a high level of acceptability with this workplace and participants reported that the tracker was a useful tool to help change behaviour.

There was a non-significant decrease of just under an hour per day from baseline to after the six-week intervention in self-reported total time spent sitting on a usual day when working at the office. Whilst there was a non-significant change post-intervention overall, almost half of the participants decreased their self-reported overall sitting time on a usual day when working at the office by at least 30 minutes per day and 40% of participants decreased sitting time by at least 60 minutes per day. Previous studies have found that problem solving techniques such as action planning and electronic prompts were effective in reducing sitting time at work (23, 24, 26). Anecdotally, participants indicated that the intervention provided a level of comradery in the office and so they were more likely to prompt each other to move or to comment on others' results (which were visible through the app) when at the office. Previous studies have shown that social support is positively associated with participation in workplace health activities (32), and that potentially this need for social support may be elevated in a flexible workplace, as day-to-day social interactions may be diminished (35). Further investigation is needed to determine the impact of social support in flexible workplace interventions.

The lack of office comradery for change may have contributed to the lack of improvement in overall sitting time when working at home. There was a non-significant increase of 20.5 minutes per day in self-reported sitting time on a usual day when working at home. Previous studies have indicated that employee sitting patterns are negatively impacted by the introduction of flexible work (35, 47). It is possible that the lack of other work-related activities (e.g. telephone calls, meetings/interactions with colleagues) in a home environment allows for a greater focus on work tasks, which in turn may reduce the effectiveness of prompts that can be easily ignored or delayed. Whilst there was non-significant change post-intervention overall, 40% of participants decreased their self-reported overall sitting time by at least 30 minutes per day when working at home and almost a quarter of participants decreased their sitting time by at least 60 minutes per

day. Further investigation is required to understand the variability in these results and how a flexible work environment may influence sitting time when working at home.

This study demonstrated that the brief intervention using activity trackers was highly acceptable in this flexible workplace. Participants reported that they liked to monitor their own behaviour and that the tracker was a useful tool to create positive change. This is interesting to note given that there were no significant changes in sitting time. The intervention protocol may therefore benefit from a mid-point review to provide feedback on progress, so that participant perceptions and actual behaviour change can be compared. The Jawbone smart tracker device was chosen for this study as it had an inbuilt idle alert that could be used to prompt reductions in prolonged sitting time. However, it is still primarily a device to track and increase awareness of activity levels (step count, exercise, etc), and so it may be less effective in increasing awareness of and changing sedentary behaviour. This is consistent with a recent study that indicated that wearable activity trackers did not reduce sedentary time (48). However, it should be noted that the primary aim of that previous study was to increase stepcounts, not to reduce sedentary behaviour. In addition, responding to prompts and self-regulation for change require a level of intrinsic motivation. Anecdotally, participants reported that at times of high work demands it was 'easy to ignore' the prompts and simply forget that so much time had passed. Future studies could attempt to overcome this through strategies targetting additional mechanisms to help guide behavioural change at these "high risk" times.

This pilot study suggests that this brief self-directed intervention, although not demonstrating statistically significant changes, may have promise with many participants decreasing overall and work-related sedentary behaviour when working at the office and when working at home. This study was limited by a small sample size which increases vulnerability to individual variation, and this may have contributed to the non-significant results. Given the promising results, a larger trial is needed to determine the effectiveness of this intervention. It is also possible that more time may be required for individuals to assimilate behaviour changes into day to day practice. This brief intervention ran for six weeks, during which time most participants would have worked from home on only six occasions and a longer timeframe may be more appropriate to address this different work pattern and demonstrate significant change. In addition, this study used Actigraph accelerometers as an objective outcome measure. Whilst the accelerometer data were consistent with the self-report data, it may be possible that more sensitive devices such as Activpal accelerometers may be more appropriate in future investigations of sedentary behaviour.

Conclusion

There is a need to develop and evaluate sedentary behaviour interventions suitable for a flexible workplace. In this study, a brief self-directed intervention using smart trackers produced a non-significant decrease of 56 minutes per day in sitting time when working at the office and a non-significant increase of 20.5 minutes per day in sitting time when working at home. Whilst there was no statistically significant change overall, this program showed promising results with many participants decreasing sitting time post-intervention. Furthermore, this intervention had high acceptability with this participant group who reported that smart trackers were a useful tool to help change sedentary behavior. Larger brief intervention studies and trials with additional intervention strategies are needed to assess effectiveness of this type of approach. Social connections seemed an important component for change in this work group, and so may be worth exploring further. This study also provided further evidence that employee sitting patterns are different when working at home and working in the office. Further research is needed to understand the relationship between a flexible workplace and sedentary behavior/physical activity. This improved understanding will assist health promotion professionals to design targeted interventions for this unique work environment.

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References

1. Thorp A, Dunstan D. Stand Up Australia: Sedentary behaviour in workers. Medibank Private; 2009.
2. Parry S, Straker L. The contribution of office work to sedentary behaviour associated risk. *BMC Public Health*. 2013;13:296.
3. Andersen JH, Fallentin N, Thomsen JF, Mikkelsen S. Risk factors for neck and upper extremity disorders among computers users and the effect of interventions: an overview of systematic reviews. *PLoS One*. 2011;6(5):e19691.
4. Al-Eisa E, Egan D, Deluzio K, Wassersug R. Effects of pelvic asymmetry and low back pain on trunk kinematics during sitting: a comparison with standing. *Spine*. 2006;31(5):E135-43.
5. Chau JY, van der Ploeg HP, Merom D, Chey T, Bauman AE. Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. *Preventive Medicine*. 2012;54(3):195-200.
6. Pronk NP, Martinson B, Kessler RC, Beck AL, Simon GE, Wang P. The association between work performance and physical activity, cardiorespiratory fitness, and obesity. *Journal of Occupational and Environmental Medicine*. 2004;46(1):19-25.
7. Robroek SJW, van den Berg TIJ, Plat JF, Burdorf A. The role of obesity and lifestyle behaviours in a productive workforce. *Occupational and Environmental Medicine*. 2011;68(2):134-9.
8. Duijvenbode DCV, Hoozemans MJM, Poppel MNMV, Proper KI. The relationship between overweight and obesity, and sick leave: a systematic review. *International Journal of Obesity*. 2009;33(8):807.

9. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Medicine & Science in Sports & Exercise*. 2009;41(5):998.
10. Dunstan DW, Barr ELM, Healy GN, Salmon J, Shaw JE, Balkau B, et al. Television Viewing Time and Mortality: The Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation*. 2010;121:384-91.
11. Owen N, Healy GN, Matthews CE, Dunstan DW. Too Much Sitting: The Population-Health Science of Sedentary Behavior. *Exercise and Sport Sciences Reviews*. 2010;38(3):105-13.
12. van der Hayden J, Asztalos M, de Bourdeaudhuij I, Cardon G. P1-83 Physical activity and the potential independent detrimental mental health outcomes of sedentary behaviour in the general population. *Journal of Epidemiology and Community Health*. 2011;65(Suppl 1):A90.
13. Teychenne M, Ball K, Salmon J. Sedentary behavior and depression among adults: A review. *International Journal of Behavioral Medicine*. 2010;17:246.
14. Mayer M. The end of flexible working? *Strategic Direction*. 2013;29(6):15-7.
15. Bureau of Labor Statistics USDoL. 24 percent of employed people did some or all of their work at home in 2015 <https://www.bls.gov/opub/ted/2016/24-percent-of-employed-people-did-some-or-all-of-their-work-at-home-in-2015.htm> [
16. Goetzel RZ, Pronk NP. Worksite Health Promotion. *American Journal of Preventive Medicine*. 2010;38(2):S223-S5.
17. Norman G, Taitel M. Strategies for maximizing participant engagement and sustained involvement in wellness programs. *Employee Benefit Plan Review*. 2010;6(11):6-10.

18. Gardner B, Smith L, Lorencatto F, Hamer M, Biddle SJ. How to reduce sitting time? A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. *Health Psychology Review*. 2016;10.
19. Lyons EJ, Lewis ZH, Mayrsohn BG, Rowland JL. Behavior change techniques implemented in electronic lifestyle activity monitors: a systematic content analysis. *Journal of Medical Internet Research*. 2014;16(8):e192.
20. Wang JB, Cataldo JK, Ayala GX, Natarajan L, Cadmus-Bertram LA, White MM, et al. Mobile and Wearable Device Features that Matter in Promoting Physical Activity. *Journal of mobile technology in medicine*. 2016;5(2):2-11.
21. Cadmus-Bertram LA, Marcus BH, Patterson RE, Parker BA, Morey BL. Randomized Trial of a Fitbit-Based Physical Activity Intervention for Women. *American Journal of Preventive Medicine*. 2015;49(3):414-8.
22. Hartman SJ, Nelson SH, Weiner LS. Patterns of Fitbit Use and Activity Levels Throughout a Physical Activity Intervention: Exploratory Analysis from a Randomized Controlled Trial. *JMIR mHealth and uHealth*. 2018;6(2):e29.
23. Bond DS, Thomas JG, Raynor HA, Moon J, Sieling J, Trautvetter J, et al. B-MOBILE--a smartphone-based intervention to reduce sedentary time in overweight/obese individuals: a within-subjects experimental trial. *PLoS One*. 2014;9(6):e100821.
24. Evans RE, Fawole HO, Sheriff SA, Dall PM, Grant PM, Ryan CG. Point-of-choice prompts to reduce sitting time at work: a randomized trial. *American Journal of Preventative Medicine*. 2012;43(3):293-7.
25. Michie S, Ashford S, Sniehotta FF, Dombrowski SU, Bishop A, French DP. A refined taxonomy of behaviour change techniques to help people change their physical activity

and healthy eating behaviours: the CALO-RE taxonomy. *Psychology & Health*.

2011;26(11):1479-98.

26. De Cocker K, De Bourdeaudhuij I, Cardon G, Vandelanotte C. What are the working mechanisms of a web-based workplace sitting intervention targeting psychosocial factors and action planning? *BMC Public Health*. 2017;17(1):382.
27. Stephens SK, Winkler EAH, Trost SG, Dunstan DW, Eakin EG, Chastin SFM, et al. Intervening to reduce workplace sitting time: how and when do changes to sitting time occur? *British Journal of Sports Medicine*. 2014;48(13):1037.
28. Healy GN, Eakin EG, LaMontagne AD, Owen N, Winkler EAH, Wiesner G, et al. Reducing sitting time in office workers: Short-term efficacy of a multicomponent intervention. *Preventive Medicine*. 2013;57(1):43-8.
29. Hutcheson AK, Piazza AJ, Knowlton AP. Work Site–Based Environmental Interventions to Reduce Sedentary Behavior: A Systematic Review. *American Journal of Health Promotion*. 2018;32(1):32-47.
30. Commissaris D, Huysmans MA, Mathiassen SE, Srinivasan D, Koppes LLJ, Hendriksen IJM. Interventions to reduce sedentary behavior and increase physical activity during productive work: a systematic review. *Scandinavian Journal of Work, Environment and Health*. 2016;42(3):181-91.
31. Shrestha N, Kukkonen-Harjula KT, Verbeek JH, Ijaz S, Hermans V, Bhaumik S. Workplace interventions for reducing sitting at work. *Cochrane Database of Systematic Reviews*. 2016;3(3).

32. Jorgensen MB, Villadsen E, Burr H, Punnett L, Holtermann A. Does employee participation in workplace health promotion depend on the working environment? A cross-sectional study of Danish workers. *BMJ Open*. 2016;6(6):9.
33. Heath GW, Parra DC, Sarmiento OL, Andersen LB, Owen N, Goenka S, et al. Evidence-based intervention in physical activity: lessons from around the world. *The Lancet*. 380(9838):272-81.
34. Tamers SL, Beresford SAA, Cheadle AD, Zheng Y, Bishop SK, Thompson B. The association between worksite social support, diet, physical activity and body mass index. *Preventive Medicine*. 2011;53(1-2):53-6.
35. Olsen HM, Brown WJ, Kolbe-Alexander T, Burton NW. Physical activity and sedentary behaviour in a flexible office-based workplace: Employee perceptions and priorities for change. *Health Promotion Journal of Australia*. 2018.
36. Nutbeam D, Harris E. *Theory in a Nutshell: A Guide to Health Promotion Theory*: McGraw-Hill Book Company; 1999.
37. Bandura A. Health Promotion by Social Cognitive Means. *Health Education & Behavior*. 2004;31(2):143-64.
38. Australian Government Department of Health. *Australia's Physical Activity and Sedentary Behaviour Guidelines*. Canberra, Australia 2017.
39. Bouchard C, Blair SN, Katzmarzyk PT. Less Sitting, More Physical Activity, or Higher Fitness? *Mayo Clinical Proceedings*. 2015;90(11):1533-40.
40. Chau JY, van der Ploeg HP, Dunn S, Kurko J, Bauman AE. A tool for measuring workers' sitting time by domain: the Workforce Sitting Questionnaire. *British Journal of Sports Medicine*. 2011;45(15):1216-22.

41. Marshall AL, Miller YD, Burton NW, Brown WJ. Measuring total and domain-specific sitting: a study of reliability and validity. *Medicine & Science in Sports & Exercise*. 2010;42(6):1094.
42. Clemes SA, Connelly J, Konstantinidis T, Koivula R, Edwardson CL, Yates T, et al. Validity Of Accelerometer-derived Estimates Of Sedentary Behaviour. *American College of Sports Medicine*, 2012.
43. Australian Institute of Health and Welfare. *The Active Australia Survey: a Guide and Manual for Implementation, Analysis and Reporting*. Canberra, Australia. 2003.
44. Brown WJ, Burton NW, Marshall AL, Miller YD. Reliability and validity of a modified self-administered version of the Active Australia physical activity survey in a sample of mid-aged women. *Australian and New Zealand Journal of Public Health* 2008;32(6):535-41.
45. Peeters G, Gellecum Yv, Ryde G, Farías NA, Brown WJ. Is the pain of activity log-books worth the gain in precision when distinguishing wear and non-wear time for tri-axial accelerometers? *Journal of Science and Medicine in Sport*. 2013;16:515-9.
46. Troiano R, Berrigan D, Dodd K, Masse L, Tilert T, McDowell M. Physical Activity in the United States Measured by Accelerometer. *Medicine & Science in Sports & Exercise*. 2007.
47. Olsen HM, Brown WJ, Kolbe-Alexander T, Burton NW. Flexible Work: The Impact of a New Policy on Employees' Sedentary Behavior and Physical Activity. *Journal of Occupational and Environmental Medicine*. 2018;60(1):23-8.
48. Sloan RA, Kim Y, Sahasranaman A, Muller-Riemenschneider F, Biddle SJH, Finkelstein EA. The influence of a consumer-wearable activity tracker on sedentary time and

prolonged sedentary bouts: secondary analysis of a randomized controlled trial. BMC

Research Notes. 2018;11(1):189.

ACCEPTED

Figure 1. Participant engagement

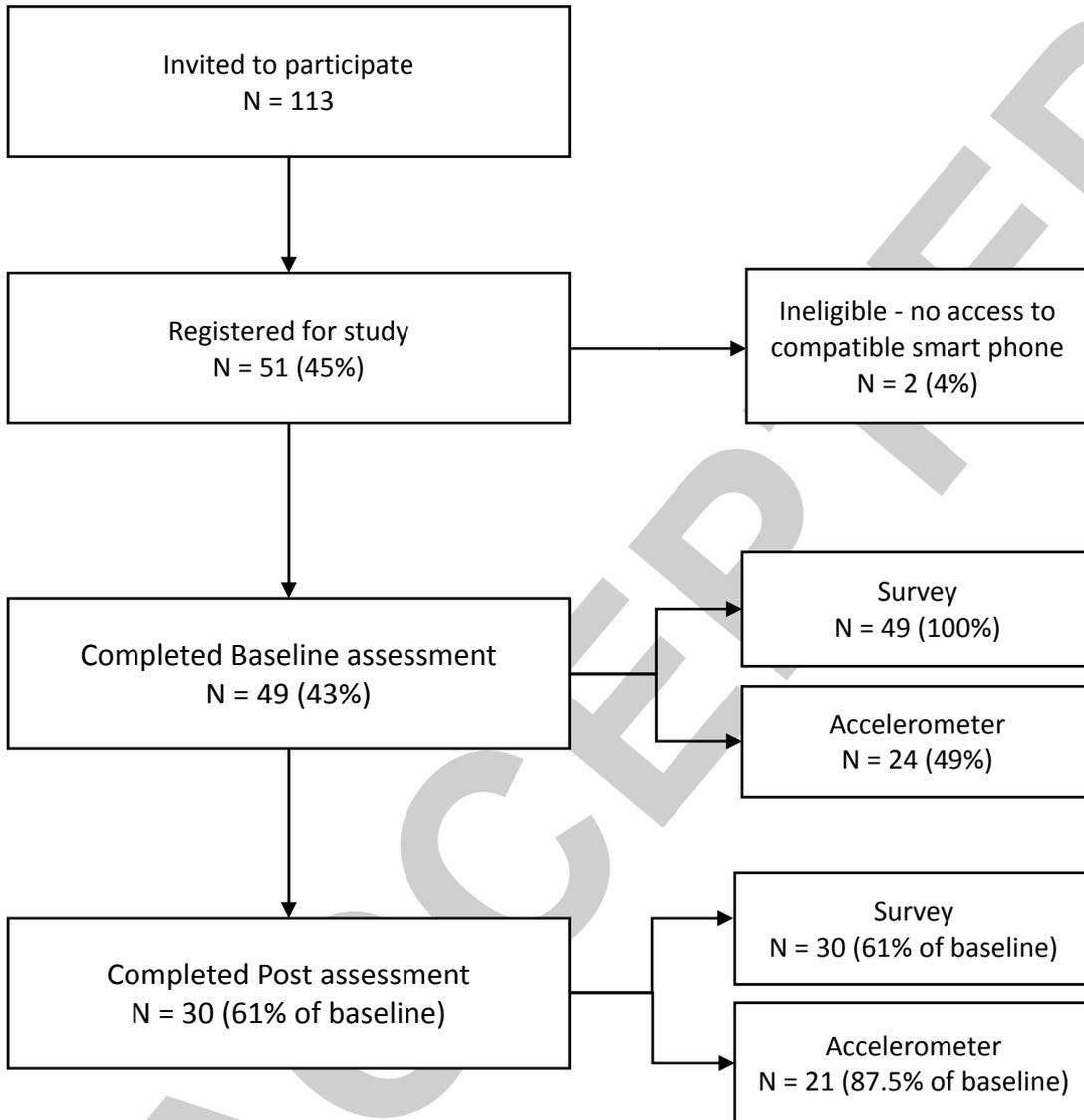


Table 1. Participant characteristics (N=30)

	Mean (SD, range)
Age (years)	39.5 (8.74, 26-59)
BMI	26.5 (5.69, 17.36-42.69)
	%
Gender	
Male	33
Female	67
Living situation	
Single	27
Single parent	3
Couple with no children	37
Couple with children	33
General Health	
Fair	27
Good	37
Very good/Excellent	36
Years of service	
Less than 2 years	15
More than 2 years	85
Mode of transport to and from work	
Car	50
Public transport (train/bus)	87
Walk	33

ACCEPTED

Table 2. Self-reported time spent sitting (minutes/day) on work days by sitting domain and work location N=30

Domain (sitting for)	On a usual day working from the office (mins/day)			On a usual day working from home (mins/day)		
	Pre Mean	Post Mean	Mean Change <i>M</i> Δ (95% CI)	Pre Mean	Post Mean	Mean Change <i>M</i> Δ (95% CI)
Work	378	357	-21 (-71, 82)	386	374.5	-12 (-83, 60)
Travel	71.5	61.5	-10 (-24, 4)	11	12	1 (-7, 8)
Television	102	80.5	-21 (-36.5, -6)	86	84.5	-1.5 (-16, 13)
Electronic device for leisure	69	58	-11 (-25, 2)	72.5	89.5	20 (-1.4, 42)
Other leisure	44	49	5 (-16, 26)	37.5	57	20 (-1.5, 42)
Total time spent sitting	662	606	-56 (-128.5, 17)	586	606	20.5 (-64.5, 105.5)

Table 3. Accelerometer recorded minutes per calendar day by activity category N=21

	Pre	Post	Mean Change
	Mean	Mean	$M\Delta$ (CI)
Sedentary	673.82	673.91	.08 (-30, 30)
Light	137.83	143.52	5.65 (-10, 21.5)
Moderate to Vigorous	36.7	33.75	-2.95 (-11, 5)

[†]Total mins in activity/#calendar days recorded

ACCEPTED

Table 4. Acceptability of brief self-directed intervention using smart tracker device

	Strongly agree/ Agree	Neutral	Strongly disagree/ Disagree
I believe the program was suitable for my work environment	93%	7%	-
I liked being able to monitor my own activity	93%	7%	-
I found the smart tracker to be a useful tool to change my behaviour	72%	6%	2%
I liked being able to work out the device myself	90%	7%	3%
I feel that I was involved in the design of the program	38%	38%	24%
I was comfortable with the level of support I received during the program	86%	7%	7%

ACCEPTED