Sitting time and step counts in office workers

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Abstract

Background: Technological advances mean that many adults are now employed in sedentary occupations. Given evidence linking prolonged sitting to chronic disease risk, understanding sitting and physical activity in and outside the workplace may usefully inform effective interventions.

Aims: To assess sitting time and physical activity during and outside working hours in full-time office workers.

Methods: Participants wore a pedometer and recorded sitting times and step counts during and outside working hours for seven days. Participants were divided into tertiles based on the proportion of time spent sitting at work. Sitting times and step counts reported outside work were compared between groups, using one-way analysis of variance.

Results: There were 72 participants. Almost two thirds (65%) of time at work was spent sitting. The sample accumulated 3742±2493 steps at work and 5159±2474 steps outside work on workdays. Participants in the highest tertile for workplace sitting reported sitting for longer than those in the lowest tertile during transport (64±59 vs 21±16 mins), after-work (154±30 vs 126±51mins) and at weekends (382±133 vs 288±124mins, all $p<0.05$). Work duration and steps reported outside work did not differ between groups.

Conclusions: Office workers who sit for a large proportion of their working day also report sitting for longer outside work. They do not compensate for their sedentary behaviour at work by being more active outside work. Occupational health interventions should focus on reducing workplace and leisure-time sitting in sedentary office workers.

Keywords: Sedentary behaviour, physical activity, occupational health, workplace health interventions, pedometer, step count

Introduction

Evidence suggests that sedentary behaviour, defined as *"any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents [METs] while in a sitting or reclining posture*" [1], is an independent risk factor for a number of adverse health outcomes. For example, greater sitting time has been associated with increased risk of obesity [2, 3], some cancers [4], type 2 diabetes and the metabolic syndrome [2, 5], and of mortality from all-causes and cardiovascular disease [6, 7].

Adults typically spend time sitting in three settings: at work, during leisure and when travelling [8]. Economic advances and industrial innovation have resulted in many people being employed in sedentary occupations. Australian workers have been shown to spend half of their total daily sitting time at work [9, 10]. Similar findings have been reported in UK workers [11]. Furthermore recent evidence suggests that individuals who sit for long periods of their working day do not compensate by increasing their physical activity levels and/or reducing their sitting time during leisure time [10, 12-14].

Our limited understanding of sitting time in UK adults is largely restricted to studies of leisure time screen-based sedentary behaviours such as computer use and television viewing, [15] or of specific occupational groups [13]. To understand better patterns and determinants of sedentary behaviour in adults, and to inform behaviour change interventions, it is important to measure all types of sedentary behaviour, in a range of settings, particularly the workplace [11]. The aim of this study was to examine sedentary behaviour and physical activity during and outside working hours in a sample of full-time office workers from England. A secondary aim was to develop our understanding of the links between occupational sitting and leisure sitting, by investigating whether those who sit for long periods at work compensate by decreasing their sitting, or increasing their physical activity, when not at work. This increased understanding could inform workplace interventions targeting physical activity and sedentary behaviour.

Methods

We recruited volunteers through advertisements posted on staff notice boards at work, and via word of mouth, from two workplaces (an insurance company and a college of further education) in the East Midlands region of England. The study was approved by the Loughborough University Ethical Advisory Committee, and participants provided written informed consent.

We measured participants' body mass (kg) and height (cm) without shoes, using electronic scales (Tanita UK Ltd) and a wall-mounted stadiometer (Seca UK) before the monitoring period. We calculated body mass index (BMI) as kg/m^2. All participants completed an initial health screening questionnaire. We measured physical activity using Yamax Digi-Walker SW-200 pedometers, worn throughout waking hours for one week. We chose pedometers given their popularity in workplace activity promotion campaigns [16]. The SW-200 pedometer has been shown to accurately detect steps taken in both free-living conditions [17, 18] and in controlled laboratory conditions in normal weight and overweight [19-21] individuals. We showed participants the appropriate position to wear the pedometer, on the waistband in-line with the midline of the anterior aspect of the thigh, at the outset. We confirmed pedometer accuracy for each participant on issue with a 20 step test (acceptance criteria: 20 +/- 2 steps recorded) [22]. Throughout the monitoring period, we asked participants to continue their normal daily routine and to record daily step counts and sitting time in a diary. On work days participants recorded their step count on arriving at work, at the start and end of their lunch break and at the end of the afternoon and their total daily step count at bed time. They also recorded their work start and finish time, morning and afternoon sitting time, time spent sitting after work, and their mode (and duration) of transport to and from work. A sample page from the diary is included in Appendix 1. On non-work days participants recorded their step counts and sitting times at the end of the day only. We only included participants with full diary entries (completed step counts and sitting

times throughout each time point of the day) on at least three work days and one non-work day in our analysis.

Statistical analyses were conducted using the IBM Statistical Package for the Social Sciences (SPSS) for Windows version 21. We calculated mean step counts and sitting times recorded at each time point throughout the working day, total step counts, sitting times and minutes spent at work. We calculated total daily sitting times on work days by summing the sitting times reported in each domain (sitting at work in the morning and afternoon, sitting during transport to and from work, and sitting after work) and compared this to total daily sitting times reported on non-work days using a paired-samples t-test. We calculated the proportion of time spent sitting at work ((sitting at work in the morning and afternoon/time spent at work) x 100) and the proportion of total daily sitting time that occurs at work ((sitting at work in the morning and afternoon/total daily sitting time) x 100). We grouped participants into tertiles based on the proportion of time (low, medium and high) spent sitting at work. We compared time reported sitting after work and sitting during travel on workdays, and total daily sitting time on non-workdays between the three groups. We also compared reported time spent at work, step counts reported during and out of working hours on work days and total step counts reported on non-work days between the groups. For all between-group comparisons we used one-way analysis of variance (ANOVA) with Bonferroni-corrected post hoc comparisons. For those participants who provided seven full days of pedometer data, we compared total step counts reported on each day of the week using repeated-measures ANOVA, with Bonferroni-corrected post hoc comparisons. Statistical significance was set at $p<0.05$ for all analyses unless otherwise stated.

Results

A one-sample Kolmogorov-Smirnov test confirmed that all data were normally distributed; descriptive data are therefore reported as the mean plus/minus the standard deviation

throughout. Preliminary analyses revealed no significant differences in step counts, sitting times or time spent at work ($p>0.05$, data not shown) between the work sites or sexes. We therefore analysed the data as a whole sample.

Of the 75 participants who commenced the study, 72 (60% female, age 37±13, BMI 24.0±3.5 kg/m^2) provided complete diaries for the seven day monitoring period of step counts and sitting time on work days and non-work days. Of these 72, 63% (45) provided complete diary entries on all seven days, 25% (18) did so on six days, 8% (6) on five days, and 4% (3) on four days. 92% (66) provided complete diary entries on both weekend days. All participants reported predominately sedentary occupations, in full-time administrative roles and telephone-based customer services. The initial health screening questionnaire confirmed that all participants were in good general health and none had any physical illnesses or disabilities that might affect their normal daily routine.

Participants reported sitting (including sitting at work, sitting out of work and sitting in motorised transport) for a total of 517±144 minutes (8 hours, 37 minutes) per day on work days and 339±137 minutes (5 hours, 37 minutes) per day on non-work days ($p<0.001$). The mean reported daily time at work was 8 hours 26 minutes ± 66 minutes, of which 327±114 minutes (65% of time at work) were reportedly spent sitting. On work days, sitting at work accounted for 63% of total daily sitting time.

83% (60) of participants reported that motorised transport was their method of commuting. The mean daily reported time spent in motorised transport was 38±41 minutes. 17% (12) reported walking or cycling to and from work.

Figure 1 shows total daily and mean step counts recorded before work, during the morning, over lunch, during the afternoon, and after work on work days, and total step counts recorded on non-work days. Mean step counts were 1345±1133 before work, 1536±1278

during the morning, 707±644 over lunch, 2134±1486 in the afternoon and 3056±1522 after work on work days. In the 63% (45) of participants who provided step count data on all seven days, total daily step counts varied significantly across the week ($F = 2.7$, $p<0.05$). Saturday step counts were significantly higher than those reported on Wednesday, Thursday, Friday and Sunday ($p<0.01$).

Insert Figure 1 about here

Participants in tertile 1 (low work-time sitters) spent less than 58% of their working hours sedentary (n = 24). Participants in tertile 2 (medium work-time sitters) spent 59 to 80% of their working hours sedentary (n = 24), and participants in tertile 3 (high work-time sitters) reported sitting for over 80% of their working hours (n = 24). Table 1 shows that when grouped into tertiles according to the proportion of time spent sitting at work (low, medium and high work-time sitters), there were significant differences in reported sitting times outside working hours between groups. High work-time sitters reported spending significantly longer sitting in motorised transport to and from work than medium and low work-time sitters (differences = 37 and 43 minutes/day respectively, $p<0.01$). High work sitters also reported sitting for significantly longer after work (on workdays) than low work sitters (difference = 28 minutes per day, $p<0.05$) and significantly greater total daily sitting times on non-workdays than low work sitters (difference = 94 minutes per day, $p<0.05$). The three groups did not differ significantly in terms of their reported work duration ($p>0.05$).

Insert Table 1 about here

The low work-time sitting group accumulated significantly more step counts during working hours compared to the medium and high work-time sitting groups (differences = 2355 and 2973 steps respectively, $p<0.01$). However, there were no significant differences in step

counts accumulated before work, during the lunch break, after work, and in total steps accumulated on non-work days between the groups (all $p>0.05$).

Discussion

In this sample of full-time office workers in central England, significantly higher levels of sedentary behaviour were reported on work days (517±144 minutes/day) compared to non-work days (339±137 minutes/day). Overall, 65% of time at work was sedentary, and sitting at work accounted for 63% of total daily sitting time. We found that those who were most sedentary at work did not compensate by reducing their sedentary behaviour outside work.

A strength of the study was our ability to measure sitting time and physical activity at discrete periods of the working day to understand how sedentary behaviour is accumulated during and outside working hours. However, whilst diaries provided valuable contextual information about how sitting is accumulated throughout the day, self-reporting may be a source of bias. The requirement for participants to record their step counts from their pedometers may have influenced their activity [23]. Inclinometers may provide a more objective measure of sedentary behaviour and physical activity [13]. A further limitation of pedometers is their inability to measure activities such as swimming and cycling. Whilst these activities were recorded by a few participants in the diary, the pedometer data was the primary measure of physical activity in this study. As with similar studies [14, 24, 25], the volunteer sample in this study may not have been representative of the entire workforce. Higher levels of sedentary behaviour on work days accords with findings in Australian workers [14, 24]. However, we found a higher proportion of total daily sitting time attributable to sitting at work than a study of Australian adults using similar measures, where 52% of total daily sitting time occurred at work [9, 10].

Step counts recorded outside working hours did not vary significantly between the three workplace sitting groups, suggesting that individuals who reported greater sitting times at

work did not compensate by increasing their activity levels outside working hours. In fact those who reported sitting for longest at work reported sitting for longer outside work, similar to findings of Jans et al. [12] and Parry and Straker [14]. However, Chau et al. [10] found that Australian workers with jobs that involve mostly sitting were more likely to report being physically active during their leisure-time than individuals in more active jobs.

In our study, the 'high work-time sitting' group also reported sitting for longer when using motorised transport, perhaps because they had longer daily commutes. These people could benefit from occupational health interventions to reduce workplace sitting. We also found that participants took relatively few steps during their lunch break (700 steps). Lunchtime could be targeted for workplace interventions to increase physical activity. Total work day sitting times of 11 hours in the 'high work-time sitting' group increases their risk of chronic conditions associated with sedentary behaviour [7]. As work represents a large proportion (>50%) of office workers' total daily sitting time, it is an ideal environment for occupational behaviour change interventions to reduce sedentary behaviour. Indeed, recent studies have investigated the effectiveness of sit-to-stand workstations for reducing sedentary time at work [26, 27]. However, our findings, and those of Jans et al. [12] and Parry and Straker [14], suggest that occupational health interventions should also address sitting outside working hours.

We studied full-time office workers with similar job roles and ranks. Further research could explore sedentary behaviour during and outside working hours in different employment sectors and grades (such as professionals, managers and technicians). This study's cross-sectional design prevents inference about causality. We cannot determine whether being sedentary at work leads to being more sedentary outside working hours. Longitudinal research could explore the long-term relationships between sedentary behaviour during and outside working hours.

Key points

- In this sample, office workers were sedentary for 65% of their working day.
- Those who reported sitting most at work also reported sitting for longer outside working hours, and did not compensate for their sedentary behaviour at work by being more active in their leisure time.
- Occupational health interventions should aim to reduce workplace and leisure-time sitting in sedentary office workers.

Conflict of Interest

The authors declare that there are no conflicts of interest. No external funding supported the work outlined in the manuscript.

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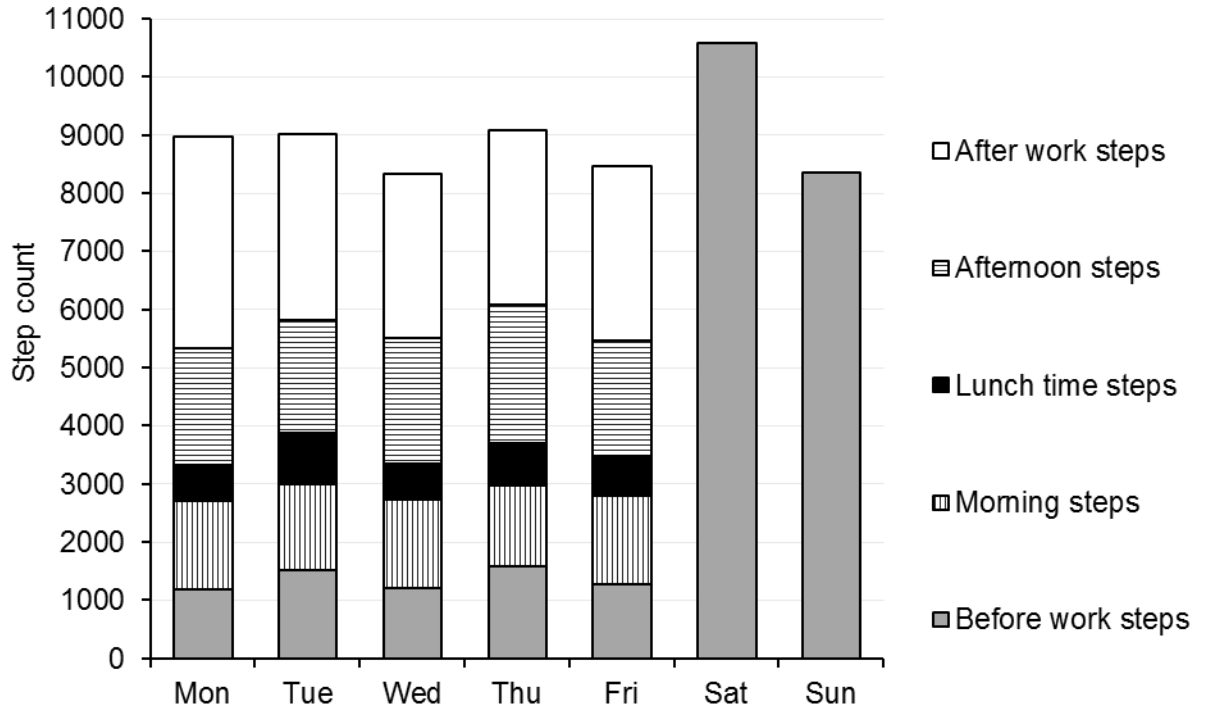
Table 1. Sitting times for 72 full-time office workers, reported on workdays (at work, during transport, after work), total sitting times and step counts reported on workdays and non-workdays, grouped as tertiles based on the proportion of time spent sitting at work.

	Low work sitters (n = 24)	Medium work sitters (n = 24)	High work sitters (n = 24)	Between group differences	
				F value	Significance
Sitting at work (minutes/day)	205 ± 76	333 ± 52	443 ± 46	96.3	***
Sitting in transport (minutes/day)*	21 ± 16	27 ± 18	64 ± 59	8.1	***
Sitting after work (minutes/day)	126 ± 51	144 ± 46	154 ± 30	3.2	*
Total sitting time on workdays (minutes/day)	352 ± 107	504 ± 69	661 ± 98	64.0	***
Total sitting time on non-workdays (minutes/day)	288 ± 124	341 ± 142	382 ± 133	3.5	*
Steps accumulated at work	5446 ± 3381	3091 ± 1297	2473 ± 1125	12.3	***
Steps accumulated out of work (on workdays)	4257 ± 1640	5773 ± 2963	5295 ± 2393	2.5	NS
Total step count on workdays	9703 ± 3359	8864 ± 3364	7768 ± 2828	4.7	*
Total step count on non-workdays	10329 ± 5825	9973 ± 5225	8284 ± 3475	1.1	NS

Figure legend

Figure 1. Step counts accumulated before work, in the morning, at lunchtime, in the afternoon and after work on workdays and total step counts on non-workdays for 72 full time office workers.



Appendix 1

Sample diary

Working Day Date: _____

1. What time did you put the pedometer on? _____

2. Before starting work, have you done any physical activity/exercise Yes* / No
* if Yes, please state what you did and the duration (e.g., walking, running, gym, housework)

Activity: _____ Duration: _____

3. Upon arriving at work please write down the time and the number of steps displayed

Start work time: _____ Steps displayed: _____

4. **At lunch time**, please indicate how long you have been sitting for since arriving at work (mins)? _____

5. At the beginning and end of your lunch break please write down the time and the number of steps displayed (if working through lunch, leave blank).

Begin lunch break, time: _____ Steps displayed: _____

End of lunch break, time: _____ Steps displayed: _____

6. **During your lunch break** did you do any activity? Yes* / No
*If Yes, please describe what you did and the duration (e.g. walking, running, gym).

Activity: _____ Duration: _____

7. Upon leaving work please write down the time and the number of steps displayed

Finish work time: _____ Steps displayed: _____

8. How long have you been sitting for since your lunch break? _____

9. Mode of transport to and from work: _____ Total duration: _____

10. Has today at work been a typical working day? Yes / No*
*If No, please give details, i.e. extraordinarily busy/stressful day/quiet day/meetings

_____

11. Have you done **any other physical activity/exercise** today not previously mentioned, i.e. out of working hours? Yes* / No
*If yes, please describe what you did and the duration (e.g. walking, running, cycling, gym, weight lifting, housework, gardening)

Activity: _____ Duration: _____

12. How long have you been sitting for since you got home from work? _____

13. What time did you take the pedometer off? _____

14. Please write down the reading on the pedometer upon going to bed: _____

Please add any additional notes that may have made this day different to your usual routine