**Descriptive epidemiology of domain-specific sitting in working adults: the Stormont Study**

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Descriptive epidemiology of domain-specific sitting in working adults: The Stormont Study

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Abstract

Background: Given links between sedentary behaviour and unfavourable health outcomes, there is a need to understand the influence of socio-demographic factors on sedentary behaviour to inform effective interventions. This study examined domain-specific sitting times reported across socio-demographic groups of office workers.

Methods: The analyses are cross-sectional and based on a survey conducted within the Stormont Study, which is tracking employees in the Northern Ireland Civil Service. Participants self-reported their daily sitting times across multiple domains (work, TV, travel, PC use, leisure) on workdays and non-workdays, along with their physical activity and socio-demographic variables (sex, age, marital status, BMI, educational attainment, work pattern). Total and domain-specific sitting on workdays and non-workdays were compared across socio-demographic groups using Multivariate Analyses of Covariance.

Results: Completed responses were obtained from 4,436 participants. For the whole sample, total daily sitting times were higher on workdays in comparison to non-workdays (625±168 vs 469±210 mins/day, p<0.001). On workdays and non-workdays, higher sitting times were reported by individuals aged 18-29 years, obese individuals, full-time workers, and single/divorced/widowed individuals (p<0.001).

Conclusions: Interventions are needed to combat the high levels of sedentary behaviour observed in office workers, particularly among the highlighted demographic groups. Interventions should target workplace and leisure-time sitting.

Keywords: Sedentary behaviour, office workers, TV viewing, screen time, occupational health interventions.
Introduction

Sedentary behaviour, defined as “any waking behaviour characterised by an energy expenditure ≤1.5 METs while in a sitting or reclining posture”(page 540), is an independent risk factor for numerous adverse health outcomes, including obesity, some cancers, type 2 diabetes, the metabolic syndrome, and mortality from all-causes and cardiovascular disease. Adults typically spend time sitting in three domains: the workplace, during leisure and for transport. Data from Australian workers suggests that 50% of daily sitting takes place at work, it has also been shown that those who sit for long periods at work do not compensate by reducing their leisure-time sitting.

Early research into sedentary behaviour focused heavily on TV viewing, however as this is only one domain of sedentary time, research has highlighted the importance of measuring all types of sedentary behaviour, across a range of contexts, if we are to truly understand patterns and determinants. A greater understanding of sedentary behaviour accumulated across multiple domains, along with potential links between sedentary time accumulated during and outside working hours, will be necessary to inform interventions and public health guidelines aimed at reducing sedentary behaviour.

In addition, there is a need for research describing the descriptive epidemiology of sedentary behaviour to help highlight at-risk groups. Research conducted on US adults has shown that self-reported sitting times increase with increasing age and increased educational attainment, whilst research on Australian adults has shown complex associations between self-reported sitting times and socio-demographic variables. Proper et al. reported positive associations between age and self-reported sitting times on weekdays, and inverse associations between age and reported sitting times during leisure-time. It was also observed that those with lower levels of education reported less sitting on weekdays, but higher levels on weekend days. This study highlights the importance of assessing sedentary behaviour on both weekdays and weekend days given the potential differences in sitting across socio-demographic groups.

Limited research has described sedentary behaviour occurring across multiple domains on weekdays (or workdays) and weekend days (non-workdays) across socio-demographic groups. Furthermore, no research has examined the descriptive epidemiology of sedentary behaviour in UK adults. Our understanding of the prevalence of sedentary behaviour in UK adults is limited, and has largely been restricted to the study of leisure-time screen-based sedentary behaviours, small samples, or to specific occupational groups, such as postal workers. Differences in patterns of sedentary behaviour have been observed.
between Australian and UK office workers, highlighting the importance of studying such lifestyle behaviours in different populations due to environmental and cultural differences.

The aim of this study therefore was to investigate sedentary times reported across multiple domains on both workdays and non-workdays according to socio-demographic characteristics from a large sample of UK office workers. A secondary aim was to examine links between occupational and leisure-time sitting.

Methods

Participants

The present analyses are cross-sectional and based on a survey conducted as part of the Stormont Study in September 2012, which is tracking a large cohort of employees within the Northern Ireland Civil Service (NICS). All NICS employees (civil servants are public sector workers, employed within a UK national government department or agency) with an occupational email address (~26,000) were invited to participate in an online survey. 5,235 employees (20% response rate) completed the survey. The Ethics Committee of the University of Ulster approved the study.

Measurement of sedentary behaviour and physical activity

Participants reported the time they usually spend sitting (hours/minutes) across 5-domains (travel, at work, watching television, using a computer at home, other leisure activities) on a typical workday and non-workday using the Domain-Specific Sitting Time questionnaire. This self-report tool provides a valid and reliable measure of total sitting time, and domain-specific sitting on workdays in adults, and is recommended for use in research examining links between sedentary time and health in working populations. Total daily sitting times on workdays and non-workdays were calculated for each participant by summing reported sitting times across the domains.

Participants reported their activity levels using a valid and reliable single-item measure of physical activity. This provided an assessment of physical activity against the 2004 physical activity guidelines for England. Participants reported the number of days they conducted at least 30-minutes of moderate-to-vigorous activity over the past week. Participants were classified as meeting the 2004 guidelines if they reported participating in at least 30-minutes of moderate-to-vigorous activity on 5 days or more.

Socio-demographic variables

Participants reported their sex, age, educational attainment, marital status, full-time or part-time work pattern, and salary band. For the analyses, age was coded into five groups (18-29,
30-39, 40-49, 50-59 and 60-70 years); while educational attainment was coded into four groups (school level, further education, university degree, or higher degree). Marital status was recoded into two groups (married/cohabiting and single/divorced/widowed). BMI was calculated from self-reported height and weight, participants were categorised as normal-weight (BMI <25 kg/m²), overweight (BMI 25–29.9 kg/m²) or obese (BMI ≥30 kg/m²).  

Statistical analyses
Analyses were conducted using IBM SPSS Statistics for Windows version 21. For the sample as a whole, total daily sitting times were compared between workdays and non-workdays using a paired t-test. To understand any differences in sitting behaviour on workdays and non-workdays across socio-demographic groups a series of multivariate analyses of covariance (MANCOVAs) compared total daily sitting times, and domain-specific sitting according to sex, age group, BMI category, educational group, marital status, individuals meeting/not meeting activity guidelines, full-time/part-time workers, and salary band. Age, sex and part-time/full-time work status were included as covariates within each MANCOVA model, with the exception of when one of these variables was the independent variable. To account for the multiple domains of sitting included in each between-group comparison the significance level for between group differences was set at p<0.004 (0.05 x 12 sitting time variables). The significance value was reduced further (p<0.001) for any post hoc analyses resulting from a significant MANCOVA result.

Participants were grouped into quartiles based on the amount of time reported sitting at work on workdays. Quartile 1 (low work sitters) consisted of individuals who reported sitting under 345 minutes/day at work. Participants in quartile 2 (low-medium work sitters) reported sitting at work between 345 – 394 minutes/day. Quartile 3 (medium-high work sitters) reported sitting between 395 – 449 minutes/day, while quartile 4 (high work sitters) reported sitting at work for over 450 minutes/day. Comparisons were undertaken between these work-time sitting groups to examine whether the groups differed in terms of reported sitting across other domains. These comparisons were undertaken using a MANCOVA, with sex, age, part-time/full-time working status and physical activity included as covariates. Bonferroni-corrected post hoc comparisons were undertaken in the event of a significant MANCOVA result.

Results
Of the 5,235 participants who completed the survey, 4,436 (85%) office workers provided complete responses on the domain-specific sitting time questionnaire. The sample included in the analyses did not differ significantly to the overall NICS employee cohort in terms of
age (mean age: 44.2 versus 43.0 years [NICS employees], p>0.05), gender proportion (56% versus 50.2% female [NICS employees], p>0.05), and proportion of full-time/part-time workers (82.8% versus 81.7% full-time [NICS employees], p>0.05).

For the sample as a whole, total daily sitting times were significantly higher on workdays in comparison to non-workdays (p<0.001) (Table 1). On workdays, sitting at work accounted for 60% of total daily sitting time, followed by watching television (15%), travelling (12%), using a computer at home (7%) and other leisure activities (6%). On non-workdays the largest contributor to total daily sitting was watching television (36%), followed by other leisure activities (23%), using a computer at home (14%), work (14%) and travelling (13%).

Total daily sitting times did not vary significantly between males and females on workdays, however males reported sitting for significantly longer on non-workdays (p<0.001). Males reported sitting for significantly longer whilst watching television and using a computer at home on workdays and non-workdays, whilst females reported sitting for significantly longer at work on workdays and in other leisure activities on non-workdays (all p<0.001) (Table 1).

Table 1

Total daily sitting times on workdays and non-workdays were significantly higher amongst the 18-29 year olds than all other groups (p<0.001). Participants aged 18-29 and 30–39 years reported sitting for significantly longer at work on workdays, and whilst using a computer at home on non-workdays than the remaining groups (all p<0.001). On non-workdays 18-29 year olds reported sitting for significantly longer in other leisure activities than all other groups (p<0.001).

Obese participants reported significantly higher total daily sitting times on workdays and non-workdays in comparison to normal-weight and overweight individuals (p<0.001). On workdays and non-workdays overweight and obese participants reported sitting for significantly longer whilst watching television in comparison to normal-weight participants (p<0.001).

Those educated to school level reported sitting in transport for significantly less time than the remaining educational groups on workdays (p<0.001). No other significant differences occurred for workday sitting between educational groups. On non-workdays participants educated up to school level reported sitting for significantly longer whilst watching television
in comparison to all other groups, this group also reported significantly higher total daily sitting times than those educated to degree, or higher degree levels (p<0.001).

Participants who were single/divorced/widowed reported significantly higher total daily sitting times on both workdays and non-workdays in comparison to those who were married/cohabiting (p<0.001). On workdays, participants who were single/divorced/widowed reported sitting for significantly longer in leisure activities, whilst on non-workdays these individuals reported sitting for significantly longer whilst watching television, using a computer at home and in other leisure activities (all p<0.001).

On workdays, total daily sitting times were significantly higher in those not meeting the 2004 physical activity guidelines (p<0.001). These individuals reported sitting for significantly longer whilst travelling, at work and whilst watching television. Individuals who did not meet the physical activity guidelines also reported sitting for significantly longer whilst watching television on non-workdays (all p<0.001).

Full-time workers reported significantly higher total daily sitting times on both workdays and non-workdays in comparison to part-time workers (p<0.001) (Table 2). These individuals reported sitting for significantly longer whilst at work on workdays, and whilst watching television and in other leisure activities on non-workdays (all p<0.001).

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
</table>

Participants with reported annual incomes below £20k reported significantly lower total daily sitting times on workdays, and less sitting whilst travelling and at work on workdays, in comparison to all other groups (all p<0.001) (Table 2). This finding was reversed however on non-workdays, where individuals with reported incomes below £20k reported significantly higher total daily sitting times than all other groups (p<0.001). Participants earning above £40k reported significantly lower amounts of sitting whilst watching television on non-workdays in comparison to all other groups (p<0.001).

When split into quartiles according to the time reported sitting at work on a workday, significant differences in reported sitting times in domains outside work were observed between groups (after controlling for age, sex, physical activity and part-time/full-time status, p<0.001). On non-workdays, total daily sitting times increased incrementally across the 4 quartiles for workplace sitting (Table 3), with individuals in the lowest quartile for workplace sitting reporting significantly lower total daily sitting times in comparison to participants in the
remaining quartiles (p<0.001). On both workdays and non-workdays participants in the medium-high and high workplace sitting quartiles reported sitting whilst watching television for significantly longer than those in the lowest quartile. Those in the highest quartile for workplace sitting reported engaging in physical activity on less days per week in comparison to those in the lowest quartile (2 days/week versus 3 days/week, p<0.001).

**Table 3**

**Discussion**

**Main finding of this study**

This study examined sedentary behaviour across multiple domains on workdays and non-workdays in office workers from Northern Ireland in the UK. Participants accumulated high volumes of sedentary behaviour on workdays (10 hours, 25 minutes) and non-workdays (7 hours, 50 minutes). It was observed that those who reported sitting the longest at work also reported sitting for significantly longer on non-workdays. These individuals reported significantly less leisure-time physical activity than those in the lowest quartile for workplace sitting, suggesting that those who are highly sedentary at work do not compensate by reducing their sedentary behaviour outside work, and/or increasing their physical activity.

The most prominent sedentary behaviours reported outside work, where differences between socio-demographic groups were most evident, were television viewing and using a computer at home. These screen-based behaviours were most prevalent amongst males, younger adults, obese individuals, individuals educated up to school level, those not meeting physical activity guidelines, single/divorced/widowed adults, full-time workers and high work-time sitters. The links between screen-based sedentary behaviours and poor health outcomes in adults have been widely reported and it is suggested that interventions targeting reductions in sedentary behaviour outside the workplace target these popular leisure-time sedentary pursuits. Encouraging individuals to stand and move during television advert breaks, and/or between programmes; or encouraging individuals to adhere to weekly limits of screen time could lead to reductions in these behaviours.

**What is already known on this topic**

It is becoming widely acknowledged that sedentary behaviour is an independent risk factor for numerous adverse health outcomes. Despite this, sedentary behaviour is the most prevalent behaviour seen throughout waking hours in adults and children. Evidence from Australian workers has shown that half of their total daily sitting time takes place at work. The findings from the current study, and other UK-based studies suggest
however that sitting at work contributes a greater (>60%) proportion of total daily sitting in UK workers. Limited evidence currently exists on socio-demographic differences in sitting. Studies examining such differences have largely been restricted to total daily sitting time, with limited research exploring socio-demographic differences in sitting across different domains.\textsuperscript{17,18,31}

As observed in an Australian sample,\textsuperscript{18} in the present study males reported sitting for significantly longer on non-workdays than females. This study has demonstrated however that screen-based sedentary behaviours account for the largest differences in sitting between the sexes outside working hours. As reported elsewhere,\textsuperscript{31} the present study also found that sitting times were higher amongst younger adults (18-29 year olds). This finding could reflect differences in cultural norms across age groups, with younger adults engaging with more technology-driven entertainment in their leisure-time.\textsuperscript{31} The high volumes of sedentary behaviour observed in young adults is concerning and could suggest that these individuals will have an increased risk of chronic diseases later in life.\textsuperscript{31} The present study observed that those educated up to school level reported significantly higher total daily sitting times on non-workdays. This finding is similar to that of Proper et al.\textsuperscript{18} who observed that those with lower levels of education reported sitting less on weekdays, but more on weekend days.

\textbf{What this study adds}

This study extends our knowledge on sedentary behaviour accumulated across multiple domains among different socio-demographic groups. It is one of the first to examine a range of sedentary behaviours on both workdays and non-workdays. The differential influences of some socio-demographic variables, such as educational attainment, on workday and non-workday sedentary behaviours highlights the importance of measuring sedentary behaviour on both types of day if we are to truly understand the effects of different determinants of sedentary behaviour. While the sample as a whole accumulated high volumes of sedentary behaviour, the highest levels of sitting were seen amongst younger adults, obese individuals, full-time workers and single/divorced participants. These socio-demographic groups should be targeted for interventions designed to reduce sedentary behaviour. Whist differences in total workday sitting between demographic groups may appear modest, for example, total daily sitting was greater by 30 minutes/day in obese individuals compared to normal-weight individuals, it has been shown that reallocating 30 minutes of sedentary time per day to light movement is associated with a 2-4\% improvement in blood biomarkers such as triglycerides and insulin levels.\textsuperscript{33} Reductions in sitting by just 30 minutes per day could therefore have clinically meaningful effects on health.\textsuperscript{34}
The findings add to the growing evidence highlighting the workplace as an important setting for the accumulation of high volumes of sedentary behaviour.\textsuperscript{10-12,16} Given its large contribution to sedentary time on workdays, workplace interventions designed to reduce, or break up, sedentary behaviour are urgently needed in UK office workers. Research in Australian and Swedish workers has started to investigate the effectiveness of sit-to-stand workstations for reducing sedentary time at work.\textsuperscript{35,36} If successful, the incorporation of sit-to-stand workstations in offices within the UK could be an effective strategy for reducing sedentary behaviour, and associated disease risk. Current findings suggest that worksite interventions should also target reducing leisure-time sedentary behaviours, particularly screen-based behaviours.

\textbf{Limitations of this study}

Whilst the analyses were based on a large sample, the poor response rate (20\%) is a limitation. However, response rates between 20-25\% are common in workplace organisational and wellbeing studies such as this (for example: Houdmont et al.\textsuperscript{37} – 23\%; Kinman and Court\textsuperscript{38} – 23\%; Allisey et al.\textsuperscript{39} – 25\%). Participants included in the analyses did not differ to the NICS employee cohort in terms of age, gender proportion and part-time/full-time working patterns, suggesting the current sample were largely representative of NICS employees. The wide age-range of the sample (19 – 70 years), and the relatively even gender split, suggest the sample were also reflective of office workers outside the NICS. Reported total daily sitting times, and time reported sitting at work, are similar to sitting times reported from office workers recruited from private and public sector organisations in England.\textsuperscript{20,21,40} Whilst the domain-specific sitting time questionnaire is a valid and reliable measure of total daily sitting time, and domain-specific sitting on workdays,\textsuperscript{23,24} validity coefficients are lower for this measure on non-workdays. This study was restricted to office workers, the findings therefore cannot be generalized to individuals employed in non-office based occupations. The cross-sectional design prevents us from making conclusions about causality; it is not possible to determine whether being sedentary at work leads to an individual being more sedentary out of working hours. Longitudinal research is required to understand long-term relationships between sedentary behaviour accumulated during and outside working hours. Despite these limitations, the large sample size, the number of different socio-demographic characteristics examined along with the multiple domains of sitting reported on both workdays and non-workdays are strengths of the study.
References


### Table 1. Mean (± SD) total and domain-specific daily sitting times (minutes/day) reported on workdays and non-workdays by the sample as a whole, and according to sex, age group, BMI category, highest level of educational attainment, marital status, and physical activity level.

<table>
<thead>
<tr>
<th></th>
<th>Workday domain specific sitting and total sitting (mins/day)</th>
<th>Non-workday domain specific sitting and total sitting (mins/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Travel</td>
</tr>
<tr>
<td>Total sample</td>
<td>4436</td>
<td>79 ± 56</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>1945</td>
<td>81 ± 57</td>
</tr>
<tr>
<td>Females</td>
<td>2491</td>
<td>77 ± 55</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 - 29 years</td>
<td>391</td>
<td>76 ± 49</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>1055</td>
<td>78 ± 55</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>1419</td>
<td>80 ± 56</td>
</tr>
<tr>
<td>50 - 59 years</td>
<td>1400</td>
<td>79 ± 59</td>
</tr>
<tr>
<td>60 - 70 years</td>
<td>171</td>
<td>77 ± 54</td>
</tr>
<tr>
<td><strong>BMI group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>1605</td>
<td>77 ± 53</td>
</tr>
<tr>
<td>Overweight</td>
<td>1774</td>
<td>79 ± 59</td>
</tr>
<tr>
<td>Obese</td>
<td>1045</td>
<td>80 ± 55</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School level</td>
<td>912</td>
<td>71 ± 54 a</td>
</tr>
<tr>
<td>Further education</td>
<td>1431</td>
<td>77 ± 54</td>
</tr>
<tr>
<td>University degree</td>
<td>880</td>
<td>80 ± 59</td>
</tr>
<tr>
<td>Higher degree</td>
<td>1192</td>
<td>85 ± 57</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/cohabiting</td>
<td>3091</td>
<td>80 ± 57</td>
</tr>
<tr>
<td>Single/divorced</td>
<td>1345</td>
<td>76 ± 54</td>
</tr>
<tr>
<td><strong>Meets PA guidelines</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>890</td>
<td>74 ± 60</td>
</tr>
<tr>
<td>No</td>
<td>3544</td>
<td>80 ± 55 a</td>
</tr>
</tbody>
</table>
a Sitting times were significantly different to the remaining group(s) within each socio-demographic category.

b,c Sitting times were significantly different between specific sub-groups with the same superscript.
Table 2. Mean (± SD) total and domain-specific daily sitting times (minutes/day) reported on workdays and non-workdays according to full time/part time working patterns and salary band.

<table>
<thead>
<tr>
<th>Salary band</th>
<th>Workday domain specific sitting and total sitting (mins/day)</th>
<th>Non-workday domain specific sitting and total sitting (mins/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Travel</td>
</tr>
<tr>
<td>Full time/part time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>3672</td>
<td>79 ± 56</td>
</tr>
<tr>
<td>Part-time</td>
<td>764</td>
<td>76 ± 56</td>
</tr>
<tr>
<td>Salary band</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;£20,000</td>
<td>805</td>
<td>70 ± 51(^\text{a})</td>
</tr>
<tr>
<td>£20,001-25,000</td>
<td>1280</td>
<td>75 ± 59</td>
</tr>
<tr>
<td>£25,001-30,000</td>
<td>1034</td>
<td>82 ± 57</td>
</tr>
<tr>
<td>£30,001-35,000</td>
<td>498</td>
<td>83 ± 53</td>
</tr>
<tr>
<td>£35,001-40,000</td>
<td>432</td>
<td>85 ± 53</td>
</tr>
<tr>
<td>£40,001+</td>
<td>387</td>
<td>87 ± 57</td>
</tr>
</tbody>
</table>

\(^{a}\) sitting times were significantly different to the remaining group(s) within each socio-demographic category.
Table 3. Mean (± SD) total and domain-specific daily sitting times (minutes/day) reported on workdays and non-workdays for participants grouped into quartiles according to reported time spent sitting at work on workdays.

<table>
<thead>
<tr>
<th>Quartile for time spent sitting at work</th>
<th>Workday domain specific sitting and total sitting (mins/day)</th>
<th>Non-workday domain specific sitting and total sitting (mins/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Travel</td>
</tr>
<tr>
<td>1 - low</td>
<td>1111</td>
<td>86 ± 64</td>
</tr>
<tr>
<td>2 – low/medium</td>
<td>1125</td>
<td>75 ± 56</td>
</tr>
<tr>
<td>3 – medium/high</td>
<td>1115</td>
<td>73 ± 52</td>
</tr>
<tr>
<td>4 - high</td>
<td>1085</td>
<td>80 ± 51</td>
</tr>
</tbody>
</table>

\textsuperscript{a} sitting times were significantly different to the remaining groups

\textsuperscript{b,c} sitting times were significantly different between specific sub-groups with the same superscript