
Occupational Sitting Time and Overweight and Obesity in Australian Workers

W. Kerry Mummery, PhD, Grant M. Schofield, PhD, Rebekah Steele, BHSc, Elizabeth G. Eakin, PhD, Wendy J. Brown, PhD

Background: One of the major immediate and long-term health issues in modern society is the problem of overweight and obesity. This paper examines the role of the workplace in the problem by studying the association between occupational sitting time and overweight and obesity (body mass index [BMI] ≥ 25) in a sample of adult Australians in full-time employment.

Methods: Data on age, gender, occupation, physical activity, occupational sitting time, and BMI were collected in September 2003 from a sample of 1579 adult men and women in full-time employment at the time of the survey. Logistic regression was used to examine the association between occupational sitting time and overweight and obesity.

Results: Mean occupational sitting time was >3 hours/day, and significantly higher in men (209 minutes) than in women (189 minutes, $p = 0.026$). Univariate analyses showed significant associations between occupational sitting time and BMI of ≥ 25 in men but not in women. After adjusting for age, occupation, and physical activity, the odds ratio for BMI ≥ 25 was 1.92 (confidence interval: 1.17–3.17) in men who reported sitting for >6 hours/day, compared with those who sat for <45 minutes/day.

Conclusions: Occupational sitting time was independently associated with overweight and obesity in men who were in full-time paid work. These results suggest that the workplace may play an important role in the growing problem of overweight and obesity. Further research is needed to clearly understand the association between sitting time at work and overweight and obesity in women.

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Introduction

One of the major immediate and long-term health issues in modern society is the problem of overweight and obesity. The burden of overweight and obesity includes increased risk of premature death and chronic disease,¹ as well as a reduction in the overall quality of life.² Obesity has been identified as a risk factor for numerous chronic diseases, including type 2 diabetes, coronary heart disease, high blood pressure, stroke, and certain forms of cancer.¹ In 2000, the World Health Organization estimated the number of obese adults in the world to be more than 300 million.³ In Australia, recent data show a 28% increase in the prevalence of overweight and

obesity through the decade of the 1990s, with 58% of men and 42% of women now classified as overweight or obese.^{4,5}

The causes of overweight and obesity are often varied and complex but, at a population level, have generally been attributed to energy imbalance—as a society we are expending less energy than we are taking in.^{6–8} Although logical to attribute the increased prevalence of overweight and obesity to reduced physical activity levels, most population data indicate that activity levels—especially leisure-time physical activity levels—are not changing sufficiently to explain the current increases in overweight and obesity.^{9,10} In any event, the emphasis on leisure-time physical activity levels may not accurately reflect the estimation of total energy expenditure at a population level. Studies that have attempted to imitate the energy expenditures of previous generations, either through the study of historical replications¹¹ or by study of groups who use traditional methods for farming and tilling the land¹² conclude that there has been a large decline in total physical activity in most developed countries over the past century. It would appear therefore that this decrease reflects

From the School of Health and Human Performance, Central Queensland University (Mummery, Steele), Rockhampton, Queensland, Australia; Division of Sport and Recreation, Auckland University of Technology (Schofield), Auckland, New Zealand; Queensland Cancer Fund, Viertel Centre for Research in Cancer Control (Eakin), Brisbane, Queensland, Australia; and School of Human Movement Studies, University of Queensland (Brown), Brisbane, Queensland, Australia

Address correspondence and reprint requests to: Kerry Mummery, PhD, School of Health and Human Performance, Central Queensland University, Rockhampton, Queensland 4702, Australia. E-mail: k.mummery@cqu.edu.au.

increasing sedentary time during nonleisure (work) time.

In one of a small number of large-scale studies that have focused simultaneously on the measurement of both physical activity and sedentary behaviors, Martinez-Gonzalez et al.¹³ found evidence of the independent contributions of sedentary time and leisure activity to obesity in 15,239 men and women from 15 member-states of the European Union. In a smaller Australian study involving 185 mostly professional workers, and 529 mothers with young children, average total daily sitting time among those in full-time paid work was 8.2 hours, of which 4.2 hours was spent sitting at work.¹⁴ In this study, higher total daily sitting time was associated with a 68% increase in the odds of having a body mass index (BMI) >25. This association was no longer significant after adjustment for leisure-time physical activity, gender, and work pattern.

Recent research has reported that occupational physical activity varies across occupational categories. Using objectively measured physical activity during working hours, Steele and Mummery¹⁵ noted significant differences between professional and blue-collar workers in terms of daily step patterns, with individuals in professional occupations reporting significantly fewer steps. This and other similar research in the area of occupational activity,^{16,17} shows the need to study work-related activity and its association with overweight and obesity.

Other research into sedentariness as a determinant of overweight and obesity has tended to focus only on sedentariness during leisure time. Since leisure-time sitting represents only about one third of daily sitting time, it is not surprising that these studies have presented mixed results. While several studies have demonstrated significant associations between time spent watching TV and BMI,^{18–20} others have found complex relationships with, for example, children who watch the greatest amounts of TV also reporting the highest levels of participation in physical activity,²¹ with no significant relationships between sedentariness and BMI. There remains a need to investigate the association between sedentary behavior at work and BMI.

Very few studies have focused on the independent effect of time spent sitting **at work** on overweight and obesity. In light of the increasing number of hours now being spent at work by the majority of working Australians,²² the main purpose of this study was to explore the relationships between occupational sitting time and overweight and obesity in a randomly selected sample of Australian adults in full-time employment.

Methods

Design

Cross-sectional self-report data were obtained in September 2003 by means of computer-assisted telephone-interview

(CATI) survey in two regional communities in Queensland, Australia. This study reports on data from 1579 individuals who reported full-time employment at the time of the study, out of a total of 2469 participants.

Sample

A two-stage stratified sampling design was used to randomly select households and individuals in the two target communities. Calls were made to 5611 eligible households in the Queensland communities of Rockhampton and Mackay in August and September 2003. All respondents were aged ≥ 18 years, and at the time of the survey were living in a dwelling unit in one of the communities that could be contacted by direct-dialed, land-based telephone service. The sample was drawn from commercially available electronic White Pages using a computer program to select, with replacement, a simple random sample of phone numbers. All duplicate mobile and business numbers were purged from the computer-generated list. Nursing homes and collective dwellings were also deleted from the sample. Within each contacted household, one eligible person was selected (based on age, gender, and availability) to act as the respondent for the interview.

Measures

The survey was conducted anonymously using CATI software to collect the data. The survey consisted of 98 questions in four sections, including a standardized introduction, a series of questions relating to physical activity participation, questions relating to perceptions of the local environment, and a set of demographic questions. The survey was approved by the Human Ethics Research Review Panel at Central Queensland University.

Age group. Age groups were established by categorizing respondents into one of four age groups: 18 to 30 years, 31 to 40 years, 41 to 50 years, and ≥ 50 years, based on self-reported age at the time of the survey.

Occupational category. Respondents provided information regarding their current occupational category as classified by the Australian Standard Classification of Occupations.²³ The nine occupational categories were subsequently collapsed into three more general categories similar to those used in existing research.^{15–17} The final classifications were as follows:

Professionals (managers and administrators, professionals and associate professionals)

White-collar workers (elementary clerical sales and service workers, intermediate clerical sales and service workers, and advanced clerical sales and service workers)

Blue-collar workers (tradespeople and related workers, intermediate production and transport workers, laborers and related workers)

Leisure-time physical activity. Self-reported physical activity data were collected using the Active Australia Survey instrument.^{24,25} Data values for individual response items >840 minutes (14 hours) were truncated to 840 minutes, and for summary response items (e.g., total weekly activity) to 1680 minutes (28 hours), as recommended by the published guide

Table 1. Descriptive statistics for occupational sitting time (minutes) with probability values for associated test of mean differences

Variable	Total sample			Men			Women		
	<i>n</i>	Sitting time mean (SD)	<i>p</i> value	<i>n</i>	Sitting time mean (SD)	<i>p</i> value	<i>n</i>	Sitting time mean (SD)	<i>p</i> value
Total sample	1579	199.9 (177.8)	—	875	208.8 (184.5)	—	704	188.8 (168.7)	—
Gender			0.026						
Male	875	208.8 (184.5)							
Female	704	188.8 (168.7)							
Age (years)			0.002			<0.001*			0.788
18–30	387	171.7 (180.7)		231	165.7 (185.7)		166	180.0 (173.7)	
31–40	405	207.4 (174.9)		227	216.7 (177.1)		196	196.5 (172.1)	
41–50	431	216.0 (178.6)		226	239.5 (186.7)		218	191.6 (166.7)	
≥50	303	202.8 (173.7)		191	215.4 (180.9)		124	183.3 (160.8)	
Occupation category^a			<0.001*			<0.001*			<0.001*
Professional	554	248.8 (175.1)		308	284.3 (176.3)			204.4 (163.5)	
White-collar worker	409	207.1 (169.1)		104	202.7 (168.7)			208.6 (169.5)	
Blue-collar worker	429	136.1 (164.0)		353	142.4 (160.9)			166.9 (175.6)	
Leisure-time activity category			0.266			0.214			0.807
Sufficiently active	661	196.7 (175.7)		365	208.5 (186.0)		296	182.1 (161.1)	
Insufficiently active	611	207.0 (179.8)		333	220.5 (185.6)		278	190.9 (171.6)	
Sedentary	270	186.7 (176.8)		158	189.3 (179.1)		112	183.1 (174.2)	
Weight category			<0.001*			<0.001*			0.672
Healthy weight	695	184.2 (173.7)		333	180.9 (176.8)		362	187.3 (170.9)	
Overweight/obese	831	214.3 (179.8)		532	226.4 (187.1)		299	192.8 (164.0)	

^aA total of 187 participants declined the opportunity to provide occupational category information.

**p*<0.001 (bolded).

SD, standard deviation.

for analysis and reporting.²⁵ The data were used to derive the following categorical measures of activity that were used in further analyses:

Sufficiently active. Respondents who reported ≥150 minutes of at least moderate-intensity activity in a minimum of five sessions during the week before the survey were classified as being “sufficiently active.” This definition is based on the *National Physical Activity Guidelines for Australians*,²⁶ which state that adults should accumulate ≥30 minutes of moderate-intensity physical activity on most, and preferably all, days of the week.

Insufficiently active. Respondents who reported <150 minutes of moderate-intensity activity, or ≥150 minutes of activity in less than five sessions during the week before the survey were classed as being “insufficiently active.”

Sedentary. Respondents were classed as sedentary if they reported no time spent in walking, or in moderate- or vigorous-intensity activities in the week before the survey.

Body mass index. BMI was calculated from self-reported height and weight (weight/height²) and categorized as “healthy weight” (BMI <25) or “overweight or obese” (BMI ≥25).

Occupational sitting time. All respondents to the general survey who reported full-time employment were asked to estimate the number of hours and minutes spent sitting during a normal working day. Respondents were subsequently classified into one of four occupational sitting time quartiles: (1) 0 to 44 minutes; (2) 45 to 149 minutes; (3) 150 to 359 minutes; and (4) ≥360 minutes.

Data Analysis

Descriptive statistics were calculated for BMI and occupational sitting time for the entire sample and by demographic characteristics and physical activity. Univariate relationships between gender, age, occupational category, leisure-time physical activity, and occupational sitting time (minutes) were analyzed using *t*-tests and analysis of variance. Associations between selected variables and calculated BMI category were explored using χ^2 tests. Logistic regression was then used to study the association between selected variables and the likelihood of being overweight or obese (BMI ≥25) adjusting simultaneously for all the variables in the model. All data were analyzed in 2004 using SPSS for Windows, version 2.0.1 (SPSS Inc., Chicago, 2003).

Results

Overall, 2469 respondents provided data for analysis, a response rate of 44.0%. Of these, 1579 respondents reported being in full-time employment at the time of the survey. This subsample was used for the subsequent analyses.

Descriptive statistics for occupational sitting time (minutes) are shown for the entire sample, and by gender in Table 1. The overall average occupational sitting time was >3 hours/day, with 25% of the sample reporting >6 hours/day sitting at work. Average daily sitting time was 20 minutes/day higher in men than in women ($t_{1577}=2.23$, $p=0.023$). Male

Table 2. Prevalence of overweight or obese (BMI \geq 25) with probability value associated with χ^2 test

Variable	Total sample			Men			Women		
	<i>n</i>	% BMI \geq 25	<i>p</i> value	<i>n</i>	% BMI \geq 25	<i>p</i> value	<i>n</i>	% BMI \geq 25	<i>p</i> value
Total sample	1579	54.5	—	875	61.5	—	704	45.2	—
Gender			<0.001*						
Male	875	61.5		—			—		
Female	704	45.2		—			—		
Age (years)			<0.001*			0.033			<0.001*
18–30	387	39.5		230	46.1		157	29.9	
31–40	405	55.8		222	65.8		183	43.7	
41–50	431	60.3		225	67.1		206	52.9	
\geq 50	303	63.4		188	68.6		115	54.8	
Occupation category			0.144			0.176			0.650
Professional	554	56.6		304	66.1		235	44.3	
White-collar worker	409	50.3		104	60.6		278	46.4	
Blue-collar worker	429	55.5		348	57.8		72	44.4	
Leisure-time activity category			0.001			0.016			0.007
Sufficiently active	661	49.2		362	58.0		278	37.8	
Insufficiently active	611	55.7		328	60.1		263	50.2	
Sedentary	270	62.9		156	71.2		103	50.5	
Daily occupational sitting time			0.004			0.002			0.513
0–44 minutes	416	47.6		214	51.9		187	42.8	
45–149 minutes	384	53.4		221	60.6		146	42.5	
150–359 minutes	502	57.5		261	64.8		228	49.1	
\geq 360 minutes	277	60.6		169	69.8		100	45.0	

* $p < 0.001$ (bolded).
 BMI, body mass index.

workers aged ≤ 30 years reported significantly less daily occupational sitting time than male workers in the three older groups ($F_{3, 1520} = 4.85$, $p = 0.002$). There was no relationship between age group and occupational sitting time in women. There were, however, significant differences in mean occupational sitting time for the three occupational categories for both men ($F_{2, 762} = 58.43$, $p < 0.001$) and women ($F_{2, 624} = 11.84$, $p < 0.001$). Post-hoc analyses showed that male professionals reported significantly higher daily sitting time than white- and blue-collar workers, while white-collar workers spent significantly more of their working day sitting than those in blue-collar occupations. In women, professional and white-collar workers spent significantly more time sitting at work than their blue-collar counterparts. There were no significant differences in sitting time between respondents in each of the three leisure-time physical activity categories ($F_{2, 1539} = 1.32$, $p = 0.26$). Although average daily sitting time was about 30 minutes less among male respondents in the healthy weight category than in those with BMI ≥ 25 ($t_{863} = -3.55$, $p < 0.001$), there were no differences in occupational sitting time for women in the two BMI categories ($t_{659} = 0.42$, $p = 0.67$) (Table 1).

Associations between BMI ≥ 25 and gender, age, occupational category, leisure-time physical activity, and daily occupational sitting quartiles are shown in Table 2. The only variable that was not associated with BMI ≥ 25 was occupational category.

The results of the logistic regression analyses investigating the associations between demographic and behavioral measures and BMI classification are presented in Table 3. The odds ratios indicate that women were less than half as likely as men to be categorized as overweight or obese. Although the odds of having BMI ≥ 25 increased with increasing age group in both men and women, there was no association between overweight and obesity and occupational classification. While women who were categorized as sedentary were 1.53 times more likely to have BMI ≥ 25 than the “sufficiently active” women, there was no association between activity categories and BMI category in the men. Among men who reported sitting for ≥ 6 hours/day, the odds ratio for having a BMI of ≥ 25 was almost twice that of those who reported sitting for < 45 minutes/day. There was no significant relationship between occupational sitting time and being overweight or obese in the women.

Discussion

A potential source of overweight and obesity in the general population is an energy imbalance in favor of intake over expenditure. There remains a need to better understand the areas where opportunities for energy expenditure are being lost in modern society. In terms of physical inactivity, the participants in this study reported an average daily occupational sitting time of > 3 hours. At a univariate level, this proxy measure of inactivity was

Table 3. Adjusted ORs for association between occupational sitting time and BMI ≥ 25

Variable	Total sample (n = 1306)		Men (n = 737)		Women (n = 569)	
	Adjusted OR ^a	95% CI	Adjusted OR ^a	95% CI	Adjusted OR ^a	95% CI
Gender						
Male	1.00	Reference				
Female	0.47	0.36–0.61				
Age (years)						
18–30	1.00	Reference	1.00	Reference	1.00	Reference
31–40	1.91	1.39–2.62	2.10	1.38–3.21	1.63	1.02–2.66
41–50	2.24	1.63–3.07	2.19	1.43–3.34	2.14	1.32–3.46
≥ 50	2.27	1.60–3.24	2.11	1.33–3.34	2.51	1.45–4.35
Occupation category						
Professional	1.00	Reference	1.00	Reference	1.00	Reference
White-collar worker	1.03	0.77–1.38	0.88	0.54–1.42	1.15	0.80–1.68
Blue-collar worker	0.91	0.68–1.23	0.83	0.58–1.18	1.16	0.66–2.05
Leisure-time physical activity						
Sufficiently active	1.00	Reference	1.00	Reference	1.00	Reference
Insufficiently active	1.32	0.95–1.83	1.28	0.82–2.00	1.45	0.88–2.38
Sedentary	1.15	0.89–1.47	0.93	0.66–1.30	1.53	1.05–2.24
Daily occupational sitting time						
0–44 minutes	1.00	Reference	1.00	Reference	1.00	Reference
45–149 minutes	1.04	0.75–1.44	1.25	0.81–1.93	0.85	0.51–1.42
150–359 minutes	1.28	0.94–1.74	1.38	0.89–2.13	1.20	0.77–1.88
≥ 360 minutes	1.48	1.04–2.13	1.92	1.17–3.17	1.06	0.62–1.82

^aOdds ratios mutually adjusted for all other variables in the table. BMI, body mass index. CI, confidence interval; OR, odds ratio.

significantly higher among overweight/obese individuals than among participants in the healthy weight range. After adjusting for age and leisure-time activity, there remained a significant association between occupational sitting time and classification of overweight and obesity in men, but not in women. The odds of men in the highest quartile for sitting time to be classified as overweight or obese were almost twice that of men in the lowest quartile. An earlier Australian study also found that men in full-time work were more likely than women to have a BMI ≥ 25 .¹⁴

The prevalence of overweight and obesity in this sample of regional Queenslanders in full-time employment was similar to that reported in national data.²⁷ Slightly more than 60% of men and 45% of women in the sample were classified as overweight or obese, compared with recent national data of 58% and 42% of men and women, respectively.⁵ Findings in this study present evidence of an association between the modern working environment and the problem of overweight and obesity, especially in men. Not only do employees spend many hours sitting, but there is a tendency for the amount of occupational sitting time to increase with age and occupational status, potentially contributing to the relationship between age and obesity commonly reported at the population level.²⁸

In a manner similar to studies that measured computer use and television viewing as proxy measures of inactivity,^{18,19,29} the primary anticipated mechanism for the

observed association between the selected measure of inactivity (occupational sitting, TV viewing, computer use) is the restriction of more physically active alternatives, due to time spent in low-energy-expenditure activities. Although it has been speculated that TV viewing also changes the amount and nature of caloric intake,³⁰ there is no evidence to support this as an alternate or compounding mechanism in terms of occupational sitting time.

Our results have significant public health implications. With the increasing prevalence of overweight and obesity clearly becoming a major public health issue in Australia and throughout the developed world, it is important to note that **inactivity** as assessed by self-reported occupational sitting time, is related to overweight and obesity, independent of physical activity classification. The results of this study suggest that even among those who report physical activity levels that reflect current national physical activity guidelines, the odds of having BMI ≥ 25 are greatly increased when occupational sitting time is >300 minutes/day. Hence the minimum “dose” of activity suggested by these guidelines (30 minutes/day of at least moderate-intensity activity) may not be sufficient to prevent obesity in those who have long sitting hours at work.

The primary limitations of this study are the cross-sectional nature of the data, which precludes firm inferences about causation, and reliance on self-reported data. Although no objective measures of BMI, physical activity,

What This Study Adds . . .

The extent to which sedentary time at work contributes to overweight and obesity is not well known.

In this cross-sectional study of almost 1600 adult men and women in Australia, occupational sitting time was found to relate to higher BMI in men but not in women.

or physical inactivity were used, the reliability and validity of the physical activity measure are established,^{24,25} and BMI is understood to be under-estimated when using self-report due to people's tendency to under-estimate weight and over-estimate height.³¹ Although several studies have reported good reliability of the sitting time questions,^{32,33} there remains a need to validate the self-report of sitting time as a proxy measure for physical inactivity at work. Results from our previous work suggest that the sitting times reported here may be under-estimated. A smaller, more controlled Australian workplace study found average sitting time at work to be almost 5 hours/day, and this sample included part-time as well as full-time employees.³³ Twenty-five percent of the current sample reported sitting for ≥ 6 hours on working days, but the mean sitting time was < 3.5 hours/day. Recent work by Steele and Mummery¹⁵ reported that a sample of white-collar and professional workers spent $> 80\%$ of their working time, or > 6 hours in an 8-hour day in light occupational activities of less than three metabolic equivalents (METs). In contrast with these two smaller studies, one of the strengths of the current study was the random selection of a relatively large population sample.

The current findings present the sedentary workplace as a potentially hostile environment in terms of overweight and obesity. The proclivity of the modern workplace for labor-saving technology reduces incidental physical activity, and with it the caloric expenditure needed to maintain healthy body weight. The immediate association between occupational sitting time and overweight and obesity presented here may be a precursor to an association between occupational sitting time and chronic disease in the working population. For example, a large U.S. cohort study has shown that each 2-hour increment in sitting time at work is associated with a 7% increase in type 2 diabetes.³⁰ Time and productivity loss due to chronic diseases associated with overweight and obesity may make it financially worthwhile for employers to be more proactive in the health of their employees by promoting physical activity at work.

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