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## **Prolonged sitting in cars: Prevalence, socio-demographic variations, and trends**

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**Keywords:** sedentary behavior, transport, travel survey, commuting

### **Conflict of Interest**

The authors declare there is no conflict of interest.

## **Abstract**

**Background:** Prolonged sitting is detrimentally associated with health outcomes. However, the prevalence and characteristics of those who sit in cars for long periods are not well understood. This study examined the population prevalence, socio-demographic variations, and trends for prolonged sitting in cars among adults.

**Methods:** Using the Sydney Greater Metropolitan Area Household Travel Survey, the prevalence of prolonged sitting time in cars ( $\geq 2$  h/day) was calculated for four 3-year periods (1997–99, 2000–02, 2003–05, and 2006–08) for each population subgroup. Trends were calculated as the mean change in prevalence between adjacent survey periods.

**Results:** Cars were used for 66% of the total trips recorded (n=336,505). The prevalence of prolonged sitting time in cars was 16–18% in men, and 10–12% in women. Relatively higher prevalence rates were found among middle-age groups (men: 20–22%, women: 12–15%), full-time workers (men: 21–24%, women: 14–15%), those with higher income (men: 21–25%, women: 14–16%), couples with children (men: 20–21%, women: 12–14%), and those living in outer suburbs (men: 20–23%, women: 12–13%). Trends were stable in men, but increasing in women. Several subgroups (older age; living in regional suburbs) also showed increasing trends.

**Conclusions:** These findings provide evidence to inform integrated approaches to measurement and policy development on prolonged car use among the public health, urban planning, and transport sectors.

## **INTRODUCTION**

Active transport helps people to increase their physical activity levels (Berrigan et al., 2006; Villanueva et al., 2008), and provides cardio-metabolic health benefits (Gordon-Larsen et al., 2009; Hamer and Chida, 2008). The health benefits of active transport may be partly attributable to reduced sitting during transport, as emerging research on sedentary behavior has shown that too much sitting, independent of too little exercise, has detrimental associations with chronic disease risk (Owen et al., 2010). Studies have shown that time spent sitting in a car is adversely associated with cardio-metabolic health outcomes. A cross-sectional study reported that each additional hour per day spent in a car was associated with a 6% increase in the likelihood of obesity (Frank et al., 2004). A cohort study involving 21 years of follow-up found that men who reported riding a car for more than 10 h/week had 50% greater cardiovascular mortality than those with less than 4 h/week (Warren et al., 2010). However, little is known about population characteristics of individuals with prolonged time spent sitting in cars. Transport studies that examine motor vehicle use generally focus on vehicle mileage at aggregate levels (Cervero and Murakami, 2010; Jacobson et al., 2011). Although there are studies examining the impact and correlates of automobile travel time (Frank et al., 2010; Schwanen et al., 2002), the attributes of those who sit for prolonged periods of time in cars are not well understood. Using household travel survey data, this study examined prevalence, socio-demographic variations, and trends for adults' prolonged sitting in cars.

## **METHODS**

### **Data Source**

Data from the Sydney Greater Metropolitan Area Household Travel Survey (1997–2008) were used. The data collection methods have been described elsewhere (Merom et al., 2010).

Briefly, this annual on-going survey covers Sydney (population: 4.4 million) and two adjacent areas: Newcastle (0.5 million) and Illawarra (0.4 million). About 5,000 households representative of the study area are randomly selected each year (response rates: 62–76%). Face-to-face interviews are used to collect information of trips (e.g., origin, destination, departure/arrival time, mode, purpose) made by each household member during a nominated 24-hour period. The present study focused on adults aged over 18 years. The Travel Survey conforms to the requirements of the Privacy Committee of New South Wales.

### **Measures**

Time spent in cars was the sum of the travel time in a private motor vehicle as a driver or passenger, and in a taxi for the designated 24-hour period. We classified 2 h/day or more of total sitting as prolonged sitting, as time spent in cars was highly skewed. This threshold value was derived from studies on television viewing, where 2 h/day or more is associated with increased health risk (Grontved and Hu, 2011). It is also equivalent to 10 h/week of car use (if it is used for commuting 5 days/week), which was associated with increased mortality (Warren et al., 2010).

### **Analysis**

The prevalence of prolonged time in cars was calculated for four 3-year periods (1997–99, 2000–02, 2003–05, 2006–08) for each demographic subgroup (produced based on age, work status, household income, household composition, car ownership, and suburb), separately for men and women. Suburbs in Sydney were classified into inner, middle, and outer based on the radial distance from its central business district. The Newcastle and Illawarra areas were classified as regional. Data of all survey periods were combined and logistic regression was used to estimate trends (mean change in prevalence between adjacent 3-year periods). Trends

were calculated without adjusting for socio-demographic variables in order to identify subgroups that increased sitting, inclusive of underlying social changes. Analyses were stratified by gender, as men and women can differ in patterns of automobile use (Frank et al., 2004). All estimates, calculated incorporating probability sampling weights, were representative of the population in the study area. STATA 10 (Stata Corp, College Station, Texas) was used for analysis.

## **RESULTS**

The total number of adult participants for the entire survey periods was 74,788. The total number of trips recorded was 336,505. Cars were used for 66% of those trips. The majority of car trips were short: 24% of the total car trips were 5 min or less in duration, and 40% of them were 6–15 min long. In contrast, car trips of long duration were sparse: 3% of the car trips were 60–89 min long, and only 1.5% of the trips were 90 min or longer.

Tables 1 and 2 show the prevalence and trends for prolonged sitting in cars for men and women, respectively. Overall, the prevalence was 16–18% in men, and 10–12% in women. Higher prevalence rates were found among middle-age groups, full-time workers, those with higher income, couples with children, and those living in outer (not regional) suburbs. For full-time workers living with family in outer suburbs, the prevalence of prolonged sitting in cars was 26–29% in men and 17–20% in women.

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TABLES 1 AND 2 ABOUT HERE

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Trends were stable in men, but increasing in women (with an approximately 12% increase in

prevalence from the first to the last survey period). For subgroups in men, the oldest (65+ years) and the lowest income groups showed increasing trends; younger (25–34 years), the highest income, and multiple car (3+) groups showed decreasing trends. In women, older (55–64 years), non-working, single, and regional area groups showed increasing trends; no subgroups showed significant decreasing trends.

## **DISCUSSION**

This is the first study to report population prevalence, socio-demographic variations, and trends for prolonged sitting time in cars. Overall, less than 20% of men and about 10% of women in the Greater Sydney area sit for 2 h per day or more as a driver or passenger.

Prolonged car use was higher among full-time workers living with family in outer suburbs, a profile that matches groups with low levels of walking (Merom et al., 2010). Adults in these categories are more likely to be exposed to the risk associated with the presence of prolonged sitting and the lack of physical activity.

Associations of living in outer suburbs with a higher likelihood of obesity have been reported in other studies (Feng et al., 2010), including one in Sydney (Garden and Jalaludin, 2009).

Prolonged sitting in cars may be partially responsible for this association. Car usage is a highly dominant mode for commuting in these areas (NSW Department of Transport, 2000).

Policy efforts are needed to reduce time in cars for working adults living in outer suburbs through initiatives such as transit-oriented development, park and ride (bus, train), and park and cycle. Another potential approach to reduce sitting in cars (and to increase activity) is to target short car trips (Maibach et al., 2009). We found that about a quarter of the car trips were 5 min or shorter. Some of these short trips may be done on foot or by bicycle. Health campaigns focusing on switching a short car trip to walking may be effective to reduce car

time and increase walking (Merom et al., 2005). Future research should also address the health impacts of accumulated and single-bout duration of driving.

Trends were relatively stable, but women in overall and older groups showed significant increasing trends. The Australian census reports the increase in labor force participation by women and by older age groups (55+) during the study period (Australian Bureau of Statistics, 2008, 2012), which may be a reason for the observed trends. Increasing prevalence in regional areas (Newcastle and Illawarra) was also found. As the other areas did not show such trends, increasing numbers of adults in these areas may be working farther away from home. Research examining purposes of car travels will be useful to better understand the increasing trend in prolonged sitting in cars among these subgroups.

Study limitations include a repeated cross-sectional design and collection of travel data only for a 24-hour period. However, travel surveys collected detailed information about daily travels from a large, representative sample, using a consistent method over time. This will be highly useful to understand transport behaviors, which can influence health not only through participation in physical activity but also through time spent sitting. There is the need for advocacy for integrating travel surveys with public health data to further understand the health impact of different transport modes.

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Table 1. Prevalence in percentages (95% confidence intervals) and trends for prolonged time in cars (2 h/day or more) in the Sydney Greater Metropolitan Area (1997-2008): men

		N <sup>a</sup>	1997–99 (n=9,563)	2000–02 (n=8,904)	2003–05 (n=8,287)	2006–08 (n=8,967)	Time trend <sup>b</sup>
Age	18–24	4,393	17.3 (14.9, 19.7)	16.6 (14.1, 19.1)	13.0 (10.8, 15.1)	18.1 (15.5, 20.8)	0.992
	25–34	6,515	20.4 (18.4, 22.4)	18.9 (16.9, 21.0)	17.5 (15.4, 19.7)	16.4 (14.4, 18.4)	0.914**
	35–44	7,451	21.7 (19.8, 23.6)	20.3 (18.4, 22.3)	20.3 (18.2, 22.4)	19.9 (17.8, 21.9)	0.967
	45–54	6,686	22.3 (20.3, 24.4)	20.0 (17.9, 22.1)	19.7 (17.6, 21.9)	22.3 (20.2, 24.3)	0.999
	55–64	5,011	17.6 (15.3, 19.9)	15.8 (13.5, 18.0)	18.7 (16.3, 21.1)	18.4 (16.2, 20.7)	1.041
	65+	5,665	5.9 (4.7, 7.2)	6.5 (5.0, 7.9)	6.8 (5.2, 8.3)	10.1 (8.5, 11.7)	1.213***
Work status	Full-time	21,990	23.5 (22.3, 24.7)	22.1 (20.9, 23.3)	21.2 (19.9, 22.4)	22.4 (21.2, 23.6)	0.977
	Part-time	2,869	17.3 (14.2, 20.4)	14.3 (11.3, 17.2)	16.6 (13.7, 19.4)	15.1 (12.3, 17.8)	0.971
	Other	10,862	7.3 (6.3, 8.3)	6.9 (5.8, 7.9)	6.8 (5.7, 7.9)	8.7 (7.6, 9.8)	1.062
Household income	1st quartile (low)	5,186	6.1 (4.8, 7.4)	6.2 (4.8, 7.7)	6.8 (5.2, 8.4)	8.3 (6.6, 9.9)	1.116*
	2nd quartile	8,188	15.4 (13.7, 17.0)	14.9 (13.3, 16.5)	13.2 (11.6, 14.9)	15.8 (14.0, 17.6)	0.998
	3rd quartile	10,158	21.5 (19.9, 23.0)	20.0 (18.2, 21.8)	19.3 (17.5, 21.1)	19.6 (17.9, 21.4)	0.962
	4th quartile (high)	12,189	24.5 (22.6, 26.3)	21.2 (19.6, 22.9)	20.5 (18.8, 22.1)	21.1 (19.6, 22.6)	0.945*
Household composition	One person	3,233	13.1 (10.6, 15.6)	13.5 (10.9, 16.1)	11.9 (9.5, 14.3)	13.8 (11.3, 16.3)	1.006
	Couple	9,396	14.8 (13.4, 16.3)	13.3 (11.8, 14.7)	16.1 (14.4, 17.7)	15.8 (14.3, 17.3)	1.047
	Couple with child	16,180	21.4 (20.1, 22.7)	20.3 (19.0, 21.7)	20.0 (18.7, 21.4)	20.6 (19.2, 22.0)	0.984
	Single parent	1,500	19.2 (15.1, 23.3)	15.4 (11.3, 19.4)	6.5 (3.8, 9.2)	17.4 (13.5, 21.3)	0.912
	Other	5,412	14.3 (12.4, 16.2)	13.9 (11.8, 16.0)	11.8 (9.9, 13.8)	13.8 (11.6, 15.9)	0.970
Car ownership	No car	3,273	1.6 (0.7, 2.6)	1.9 (0.8, 3.1)	2.4 (1.2, 3.7)	1.5 (0.5, 2.5)	1.000
	1 car	16,414	13.0 (11.8, 14.2)	11.6 (10.4, 12.9)	10.9 (9.6, 12.1)	12.0 (10.7, 13.4)	0.964
	2 cars	21,213	21.9 (20.5, 23.3)	21.0 (19.5, 22.5)	21.0 (19.5, 22.5)	21.6 (20.1, 23.2)	0.996
	3 cars or more	9,237	28.7 (26.4, 31.0)	24.7 (22.4, 27.1)	23.5 (21.2, 25.7)	25.0 (22.9, 27.2)	0.944*
Suburb	Inner	6,586	12.5 (10.9, 14.1)	11.9 (10.2, 13.6)	10.6 (9.0, 12.3)	10.9 (9.3, 12.6)	0.944
	Middle	8,308	16.4 (14.6, 18.1)	15.0 (13.0, 17.0)	15.2 (13.5, 16.9)	15.2 (13.4, 17.0)	0.976
	Outer	14,969	22.9 (21.5, 24.3)	20.7 (19.3, 22.1)	20.4 (18.9, 21.9)	22.5 (21.0, 23.9)	0.992
	Regional	5,858	14.1 (12.2, 16.0)	14.9 (13.0, 16.8)	14.7 (12.4, 17.1)	16.4 (14.4, 18.5)	1.057
All		35,721	18.1 (17.3, 19.0)	16.9 (16.1, 17.8)	16.6 (15.7, 17.5)	17.8 (16.9, 18.7)	0.992

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , <sup>a</sup> Combined samples from 1997 to 2008, <sup>b</sup> Unadjusted mean change between adjacent survey periods

Table 2. Prevalence in percentages (95% confidence interval) and trends for prolonged time in cars (2 h/day or more) in the Sydney Greater Metropolitan Area (1997-2008): women

		N <sup>a</sup>	1997–99 (n=10,740)	2000–02 (n=9,721)	2003–05 (n=8,999)	2006–08 (n=9,607)	Time trend <sup>b</sup>
Age	18–24	4,519	12.9 (10.8, 15.0)	13.4 (11.1, 15.6)	14.2 (11.8, 16.7)	13.5 (10.9, 16.2)	1.023
	25–34	7,264	12.5 (11.0, 14.0)	11.3 (9.8, 12.9)	12.4 (10.6, 14.2)	10.2 (8.7, 11.7)	0.944
	35–44	8,197	11.6 (10.2, 13.0)	13.5 (11.9, 15.0)	14.1 (12.3, 15.8)	13.2 (11.6, 14.8)	1.047
	45–54	7,316	12.9 (11.3, 14.5)	13.9 (12.2, 15.5)	13.5 (11.8, 15.2)	14.5 (12.8, 16.3)	1.039
	55–64	5,219	7.0 (5.5, 8.6)	9.1 (7.4, 10.9)	10.3 (8.5, 12.1)	12.1 (10.3, 13.9)	1.207***
	65+	6,552	3.9 (3.0, 4.8)	3.4 (2.4, 4.3)	3.6 (2.6, 4.6)	4.7 (3.6, 5.8)	1.078
Work status	Full-time	12,223	15.2 (13.8, 16.5)	15.3 (14.0, 16.7)	14.9 (13.4, 16.3)	14.2 (12.9, 15.5)	0.972
	Part-time	8,447	13.2 (11.6, 14.9)	12.8 (11.2, 14.4)	15.5 (13.9, 17.2)	14.5 (12.9, 16.2)	1.056
	Other	18,397	6.3 (5.5, 7.0)	7.2 (6.4, 8.0)	7.0 (6.2, 7.9)	7.7 (6.8, 8.6)	1.066*
Household income	1st quartile (low)	8,091	5.0 (4.1, 5.9)	6.1 (5.0, 7.2)	6.9 (5.6, 8.2)	5.6 (4.5, 6.7)	1.049
	2nd quartile	9,236	8.9 (7.6, 10.2)	10.2 (8.9, 11.5)	9.3 (7.9, 10.7)	10.0 (8.5, 11.4)	1.027
	3rd quartile	10,214	12.2 (10.9, 13.5)	12.2 (10.7, 13.6)	13.3 (11.8, 14.8)	13.4 (11.8, 15.1)	1.043
	4th quartile (high)	11,526	15.8 (14.2, 17.4)	14.8 (13.3, 16.2)	14.9 (13.4, 16.3)	14.4 (13.0, 15.7)	0.969
Household composition	One person	4,411	5.9 (4.6, 7.3)	7.2 (5.6, 8.9)	8.6 (6.7, 10.5)	8.7 (7.0, 10.4)	1.146**
	Couple	9,381	9.3 (8.1, 10.5)	8.7 (7.5, 9.9)	9.7 (8.4, 11.0)	10.2 (9.0, 11.5)	1.047
	Couple with child	16,130	12.2 (11.1, 13.2)	13.6 (12.5, 14.7)	13.9 (12.7, 15.2)	12.9 (11.7, 14.0)	1.020
	Single parent	3,303	10.8 (8.4, 13.2)	11.4 (9.1, 13.7)	11.4 (9.0, 13.9)	12.8 (10.0, 15.7)	1.063
	Other	5,842	9.5 (7.9, 11.1)	8.1 (6.5, 9.7)	8.2 (6.3, 10.1)	9.3 (7.6, 11.0)	0.993
Car ownership	No car	4,569	1.6 (0.7, 2.4)	2.1 (1.1, 3.0)	2.6 (1.4, 3.8)	1.6 (0.7, 2.4)	1.027
	1 car	17,940	8.1 (7.2, 9.0)	8.9 (7.9, 9.9)	8.5 (7.4, 9.5)	9.7 (8.5, 10.8)	1.053
	2 cars	20,596	13.8 (12.5, 15.0)	13.2 (12.0, 14.5)	14.2 (12.9, 15.5)	12.7 (11.6, 13.8)	0.980
	3 cars or more	8,617	15.7 (13.7, 17.8)	17.0 (15.0, 19.0)	17.7 (15.5, 19.9)	17.5 (15.3, 19.6)	1.039
Suburb	Inner	7,248	9.0 (7.6, 10.4)	8.4 (7.0, 9.7)	9.7 (8.0, 11.4)	9.8 (8.4, 11.2)	1.047
	Middle	9,215	9.3 (7.9, 10.6)	9.4 (8.1, 10.8)	9.5 (8.2, 10.7)	9.4 (8.1, 10.7)	1.005
	Outer	16,209	11.9 (10.9, 12.9)	13.2 (12.2, 14.3)	13.1 (11.8, 14.3)	13.3 (12.0, 14.5)	1.035
	Regional	6,395	8.7 (7.1, 10.4)	9.4 (7.8, 11.0)	11.6 (9.8, 13.3)	10.8 (8.9, 12.6)	1.094*
All		39,067	10.3 (9.6, 10.9)	10.9 (10.2, 11.6)	11.4 (10.7, 12.2)	11.4 (10.6, 12.1)	1.040*

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , <sup>a</sup> Combined samples from 1997 to 2008, <sup>b</sup> Unadjusted mean change between adjacent survey periods