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Adverse associations of car time with markers of cardio-metabolic risk

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ABSTRACT

Objective. To examine associations of time spent sitting in cars with markers of cardio-metabolic risk in Australian adults.

Method. Data were from 2800 participants (age range: 34–65) in the 2011–12 Australian Diabetes, Obesity and Lifestyle Study. Self-reported time spent in cars was categorized into four groups: ≤15 min/day; >15 to ≤30 min/day; >30 to ≤60 min/day; and >60 min/day. Markers of cardio-metabolic risk were BMI, waist circumference, systolic and diastolic blood pressure, triglycerides, HDL-cholesterol, fasting plasma glucose, 2-h plasma glucose, a clustered cardio-metabolic risk score, and having the metabolic syndrome or not. Multilevel linear and logistic regression analyses examined associations of car time with each cardio-metabolic risk outcome, adjusting for socio-demographic and behavioral variables and medication use for blood pressure and cholesterol/triglycerides.

Results. Compared to spending 15 min/day or less in cars, spending more than 1 h/day in cars was significantly associated with higher BMI, waist circumference, fasting plasma glucose, and clustered cardio-metabolic risk, after adjusting for socio-demographic attributes and potentially relevant behaviors including leisure-time physical activity and dietary intake. Gender interactions showed car time to be associated with higher BMI in men only.

Conclusions. Prolonged time spent sitting in cars, in particular over 1 h/day, was associated with higher total and central adiposity and a more-adverse cardio-metabolic risk profile. Further studies, ideally using objective measures of sitting time in cars and prospective designs, are needed to confirm the impact of car use on cardio-metabolic disease risk.

Background

High volumes of daily sitting time, which are now common in many countries (Matthews et al., 2008; Ng and Popkin, 2012) are associated with an increased risk of cardiovascular and other chronic diseases (Cooper et al., 2014; Healy et al., 2008; Owen et al., 2010; Thorp et al., 2010; Wijndaele et al., 2014). Of the specific sedentary behaviors, TV viewing time has been examined extensively and shown to be associated with cardiovascular mortality (Dunstan et al., 2010; Matthews et al., 2012) and markers of cardio-metabolic risk (Inoue et al., 2012; Thorp et al., 2010; Wijndaele et al., 2010). However, potential health effects of other sedentary behaviors, such as sitting in cars, have been less studied. Although sitting defines sedentary behaviors regardless of where they take place, driving can involve slightly higher energy expenditure (2.0 METs) than other sedentary behaviors such as TV viewing (sitting quietly, 1.0 METs) and sitting at work (1.5 METs) (Ainsworth et al., 2000). Recent studies have suggested that sitting in different domains may not be similarly associated with mortality and disease outcomes (Basterra-Gortari et al., 2014; Chau et al., 2012; Pinto Pereira et al., 2012). Given that different strategies may be needed to reduce sedentary behavior in different domains (leisure, transport, and occupation), it is important for practitioners and policy makers in relevant sectors to understand how particular domain-specific sedentary behaviors are related to health risk.

The proportion of adults who use a car as the main form of transport to work or for other commuting purposes is high: 86% in the USA and

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78% in Australia (Australian Bureau of Statistics, 2012; McKenzie and Rapino, 2011). Even in European countries, which can have more-compact urban environments and more accessible public transport, the majority of trips are made by cars. For example, cars are used for 64% of all instances of travel in the UK, and 53% in Sweden (Transport Analysis, 2012; UK Department of Transport, 2013). Car use is not only high in frequency, but can also be substantial in duration. Australian household travel surveys show that adults spend on average more than 50 min/day in a car (Ironmonger, 2008), with up to 18% of men and 12% of women spending more than 2 h/day (Sugiyama et al., 2012).

Car commuters have been shown to have higher odds of being overweight or obese, compared to non-car commuters (Laverty et al., 2013; Lindstrom, 2008). Frequent car use for commuting and errands has been associated with higher BMI (Pendola and Gen, 2007). A recent review has shown that longer car use (measured in time or in distance) was significantly associated with higher weight status in eight out of 10 studies (McCormack and Virk, 2014). Longitudinal studies have also found frequent and longer car use to be associated with greater weight gain and higher cardiovascular mortality (Sugiyama et al., 2013; Warren et al., 2010). These studies, however, have used predominantly self-reported adiposity measures. One study reported distance between home and work to be associated with a metabolic syndrome risk score derived from objectively-assessed biomarkers (Hoehner et al., 2012). However, such a distance measure focusing on the workplace may not accurately represent time spent sitting in cars.

As discussed above, car use is a common sedentary behavior among adults. Since it has a broad detrimental impact on society including human health, greenhouse gas emission, and congestion, producing specific evidence of how time in car is associated with increased risk of chronic diseases is relevant to help inform policies to promote active travel. We examined associations of time spent sitting in cars with objectively-measured markers of cardio-metabolic risk among Australian adults.

Methods

Data source

Data were obtained from participants of the third wave of the Australian Diabetes, Obesity and Lifestyle (AusDiab3) study, which was conducted in 2011–12. AusDiab is a cohort study that was originally established to examine the national prevalence and incidence of diabetes and related risk factors. Detailed methods of recruitment and data collection have been reported elsewhere (Dunstan et al., 2002; Thorp et al., 2010). Briefly, the initial data collection (AusDiab1) was conducted in 1999–2000, using a stratified cluster sampling method. First, six Census Collection District (CCD, a geographic unit defined by the Australian Bureau of Statistics with an average of 225 dwellings each) clusters were selected from each of the seven Australian states and territory. Within each of the 42 study areas, adults aged 25 years and over who had resided at the address for 6 months or longer prior to the survey and those without physical or intellectual disabilities were asked to participate in the survey. The sample for AusDiab 1 (n = 11,247) was a national sample of the adult population aged 25 years and over. Survey questions on car use were first introduced in AusDiab3 (n = 6,186). The response rate for this wave among eligible AusDiab2 participants was 59.8%. Of these, 4,614 participants attended testing sites for biomedical examination (Tanamas et al., 2013). The sample for the current study consisted of those who were 65 years or younger (n = 3,112). Adults older than 65 years were excluded from this analysis on the grounds that cardio-metabolic health of those who were retired (no longer driving to work) may have been influenced by previous driving habits. Of these, participants who did not report car time (n = 86), did not have more than one outcome measure (n = 21), did not answer a general questionnaire for socio-demographic variables (n = 63), were diagnosed with diabetes (n = 138), had a history of cardiovascular disease (angina, heart attack, stroke; n = 51), or were pregnant (n = 5) were excluded. The final sample size was 2,800 (exclusion criteria not mutually exclusive). The study was approved by the Ethics Committee of the International Diabetes Institute and the Alfred Health Human Ethics Committee, and written informed consent was obtained from all participants.

Outcome measures

Objective markers of cardio-metabolic risk included BMI; waist circumference; systolic and diastolic blood pressure (BP); triglycerides; HDL-cholesterol; fasting plasma glucose; 2-h post-load plasma glucose; clustered cardio-metabolic risk; and having the metabolic syndrome or not. Trained personnel at data collection sites measured participants' height, weight, waist circumference, and resting BP. Fasting serum triglycerides, HDL-cholesterol, and fasting and 2-h plasma glucose levels were measured by enzymatic methods using the Roche Modular (Roche Diagnostics, Indianapolis, IN). A continuous clustered cardio-metabolic risk score was computed using five cardio-metabolic measures: waist circumference; BP (average of systolic and diastolic); triglycerides; HDL-cholesterol; and fasting plasma glucose (Wijndaele et al., 2009). After standardizing all five markers, the risk score was calculated by summing all standardized scores and dividing this sum by five. Gender-specific means and standard deviations from all participants with complete data for each cardio-metabolic variable were used. A higher positive score denotes greater cardio-metabolic risk. Triglycerides and fasting plasma glucose were normalized (natural log) prior to standardization. The standardized score of HDL-cholesterol was multiplied by minus one, to account for its protective cardio-metabolic effect. The presence of the metabolic syndrome was determined based on the 2009 Joint Interim Statement (Alberti et al., 2009).

Exposure measure

Participants were asked to report the total duration they used a car (as driver or passenger) to get to places such as work, school, shops, or services in the last week. The question was asked in the format used for those in the International Physical Activity Questionnaire (Craig et al., 2003). Participants were categorized into four groups according to daily time spent in cars: ≤15 min/day; >15 to ≤30 min/day; >30 to ≤60 min/day; and >60 min/day.

Covariates

Socio-demographic variables were collected using an interviewer-administered questionnaire. They included age; gender; education (high school or less, technical/vocational, bachelor's degree or higher); work status (working including students, not working, other); marital status (single, couple); having children in the household (yes, no); and annual household income (less than AU$60 K, AU$60–125 K, AU$125 K or more, no response). Behavioral covariates included self-reported sitting time for work, TV viewing time, leisure-time computer use, leisure-time moderate-to-vigorous physical activity (LTPA), energy intake, and alcohol consumption. Participants reported time spent sitting as part of their work in the last week during weekdays (sitting for work), time spent sitting to watch TV or video/DVD in the last week (TV viewing), and time spent sitting to use a computer, the internet, and electronic games during leisure time in the last week (computer use). For each of them, the average daily sitting time was calculated. LTPA was determined using the Active Australia Survey, a validated and reliable questionnaire, by summing the time spent in moderate physical activity and vigorous physical activity (multiplied by two) in the last week (Armstrong et al., 2000). Daily energy intake and alcohol consumption were determined using a self-administered food-frequency questionnaire, with a reference frame of the last 12 months (Hodge et al., 2000). Daily intakes of each food were calculated using sex-specific standard portion sizes derived from weighed food records and the reported frequencies converted to daily equivalents. From these data, intakes of nutrients, including energy, were calculated using NUTTAB95 food composition data (Lewis et al., 1995). In addition, self-reported medication use for BP and for cholesterol or triglycerides were also included as covariates.

Statistical analyses

Outcome variables that had a skewed distribution (triglycerides, fasting plasma glucose, and 2-h plasma glucose) were log-transformed to reduce skewness. Multilevel linear and logistic regression analyses examined associations of time spent in cars with each outcome, using CCD clusters as a random intercept. Analyses adjusted for socio-demographic and behavioral variables described above. They also adjusted for medication use for BP (only in models examining systolic BP, diastolic BP, and cardio-metabolic risk) and medication for cholesterol/triglycerides (only in models examining triglycerides, HDL-cholesterol, and cardio-metabolic risk). Results were shown in unstandardized regression coefficients for continuous outcome measures and odd ratios for the metabolic

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