Factors Associated with Higher Sitting Time in General, Chronic Disease, and Psychologically-Distressed, Adult Populations: Findings from the 45 & Up Study

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Abstract

This study examined factors associated with higher sitting time in general, chronic disease, and psychologically-distressed, adult populations (aged ≥45 years). A series of logistic regression models examined potential socio-demographic and health factors associated with higher sitting (≥6hrs/day) in adults from the 45 and Up Study (n = 227,187), including four separate subsamples for analysis comprising those who had ever had heart disease (n = 26,599), cancer (n = 36,381), diabetes (n = 19,550) or psychological distress (n = 48,334). Odds of higher sitting were significantly (p < .01) associated with a number of factors across these groups, with an effect size of ORs ≥ 1.5 observed for the high-income ≥$70,000AUD, employed full-time and severe physical limitations demographics. Identification of key factors associated with higher sitting time in this population-based sample will assist development of broad-based, public health and targeted strategies to reduce sitting-time. In particular, those categorized as being high-income earners, full-time workers, as well as those with severe physical limitations need to be of priority, as higher sitting appears to be substantial across these groups.
Introduction

Current evidence clearly demonstrates the health benefits of adults participating in at least 30 minutes of moderate-vigorous physical activity (MVPA) on most days of the week [1]. However, recent research has shown that even when adults meet physical activity recommendations, there may be adverse metabolic and health effects from prolonged sitting [2]. Sedentary behavior and physical activity are measured using their metabolic equivalent (MET), with one MET characterising the energy expended when sitting quietly [1]. Prolonged sedentary behavior (sitting or reclining, 1–1.5 METS) [3] independently affects health and wellbeing [4–8] due to reduced energy expenditure and a lack of muscular activity [9], and has been linked to all-cause mortality and possibly overweight/obesity, cardiovascular disease, adverse metabolic profiles, osteoporosis, type two diabetes, insulin resistance and various cancers [6, 10, 11] as well as reduced psychological and social functioning [12].

In Australia, population-based self-report data indicates that adults spend approximately four hours/day engaging in sedentary leisure activities, with 30% spending more than five hours/day [13–15]. However, objective assessment (i.e., accelerometer data) suggests that adults on average spend more than half their waking hours in sedentary activities (primarily prolonged sitting, including work related activities) [16, 17].

Due to the health risks and high prevalence of sedentary behavior, higher sitting time has been identified as a global public health concern [3]. Examination of factors associated with prolonged sitting is needed to inform cost-effective and sustainable primary and secondary prevention interventions. While some research has been conducted [10, 15, 18–21], additional exploration of populations with specific chronic disease or psychological distress [22] is needed to determine whether population-based interventions should be tailored to major disease groups versus generic 'one-size-fits-all' approaches [5]. The objective of this study is to examine factors associated with higher sitting time behavior in (i) general, (ii) chronic disease (heart disease/cancer/diabetes), and (iii) psychologically distressed adult populations, among a large sample of Australian adults.

Methods

The 45 and Up Study received ethics approval from the University of NSW Human Research Ethics Committee. The University of Newcastle Human Research Ethics Committee approved this secondary analysis (H-2014-0042).

Study population

The study used baseline data from The 45 and Up Study [23], a large-scale prospective cohort study (data collected January 2006-December 2009) of over 260,000 individuals aged 45 years or older living in New South Wales, Australia, with data on socio-demographic characteristics, health conditions, and lifestyle behaviors [24], collection via a pen and paper self-report questionnaire.

Sitting Time

Sitting time was determined using a single item “About how many hours in each 24 hour day do you usually spend sitting?”. This measure is equivalent to the International Physical Activity Questionnaire (IPAQ) sitting time assessment [25]. A number of population-based studies have employed a single-item assessment of total sitting time[26]; such studies have consistently reported associations between high sitting time and poor health/mortality[27, 28]. Participants responses were then dichotomized as 'low sitting time' (≤5.5 hours/day) versus 'higher sitting
time' (>5.5 hours/day) based on the sample’s mean and related studies [24, 29]. Effectively resulted in a dichotomy of <6 vs ≥6 hours for low and higher sitting time respectively. A recent study examining the United States National Health and Nutrition Examination Survey (NHANES) data also employed a similar cut-point (i.e., 6 hours) to examine the association between sitting time and cardiometabolic risk [29]. Further, a very recent study also employed a 6-hour cut-point to examine the excess sitting time and risk of heart disease and all-cause mortality [30]. Moreover, George and colleagues [24] reported an increased risk of chronic diseases of >4 hours of sitting per day from study participants, with greater risks of 6 or more hours of sitting time.

**Demographic variables**

Demographic variables of interest included: age (derived from self-reported date of birth and categorized as 45–54, 55–64, 65–74 and 75+ years); education (no school certificate or other qualification and school or intermediate certificate, 12 years of schooling and/or non-degree certification, and university degree); marital status (married/defacto/partnered or single/widowed/divorced); annual household income (<$10,000, $10,000–$29,999, $30,000–$69,999, >$70,000 AUD) (note: the average full-time Australian income is $74,724 per annum, before tax (ABS)) [19]; work status (not working, working part-time, working full-time) and postcode (derived from the respondents’ postcode and classified according to the Australian Standard Geographical Classification (ASGC) Remoteness Index) [31].

**Clinical Variables**

Body mass index (BMI) was calculated from self-reported weight and height, which has shown excellent agreement with objectively measured BMI categories [32], and categorized as: underweight (BMI: ≤18.5); healthy weight (BMI:18.5–24.9); overweight (BMI:25.0–29.9); and, obese (BMI:≥30). Co-morbidities were assessed by participants reporting any previous diagnosis of heart disease, diabetes mellitus, and various cancers (other than non-melanoma skin cancers) by a physician. Self-rated health was assessed with a single question on a 5-point scale (ranging from poor-excellent) from the 36-item Short Form Health Survey [33]. Health limitations (function) were assessed using the Medical Outcomes Study Physical Functioning scale, which assesses the extent to which an individual’s health limits their ability to perform daily functional activities and classified as: no limitation (100); minor limitation (95–99); mild limitation (85–94); moderate limitation (60–84); and severe limitation (0–59) [34].

**Health Behaviors**

Physical activity was assessed with the Active Australia Survey [35] which measures minutes of walking and other moderate and vigorous physical activity in the past week, and has acceptable reliability and validity [36, 37]. Individuals were categorized as follows: no physical activity (0 min/week), some physical activity but not meeting recommended levels (1–149 min/week), meeting the minimum but less than twice the amount of the WHO recommendation (150–299 min/week) [38] and meeting high levels of activity (>300 min/week) [39]. Smoking status (current smoker/former smoker/never smoked) was classified based on responses to the following single item questions (with yes/no response options): ‘Have you ever been a regular smoker’ and ‘Are you a regular smoker now?’ [40]. Alcohol consumption was obtained using a single open-ended response item asking participants ‘About how many alcoholic drinks do you have each week?’ and was classified as no drinks; 1–7 drinks; 8–14 drinks; or ≥15 drinks per week [40].
Psychosocial Measures

Prevalence of psychological distress was assessed using the Kessler Psychological Distress Scale (K10) \[41, 42\] incorporating ten questions regarding the respondent’s psychological state over the past four weeks. Total scores ranging from 10 to 50, were classified as: no/low emotional disturbances (<16); moderate emotional disturbances (16–21); and high/very high emotional disturbances (22+), consistent with previous research \[43\].

Analysis

**Missing data.** Where the proportion of missing data for any covariate exceeded 5% (BMI, physical functioning, income and K10), a separate “missing” category was included in the analyses \[28\]. There were 18,671 (7%) missing on one or more of the remaining covariates, and 20,968 (7.9%) with data missing for sitting (either alone n = 11790 or also on a covariate). There was little difference in the rate of missing data on the covariates between the two sitting categories (low: 8.3%; high: 6.7%). Higher (>5%) than average rates of data missing for sitting were observed only among those aged 75 years or older (14.8% missing sitting) and/or who reported less than one minute of physical activity per week (16.6% missing sitting). Therefore, as it was likely that the data were missing at random \[44\] and age and physical activity were already included as covariates in the regression models (thereby providing model-based adjustment for the missing data on the sitting outcome) participants without complete data were excluded from the analyses.

**Statistical analysis.** Multiple logistic regression was used to investigate factors associated with higher sitting time for all respondents as well as for four subsamples: participants reporting ever having (a) heart disease, (b) cancer (except non-melanoma skin cancer), (c) diabetes (not further defined), and (d) moderate/high risk of psychological distress. All models included age, gender, education, marital status, work status, urban/rural location of residence, income, BMI, number of co-morbidities, limitation of physical function, self-rated health, physical activity, current smoking status, alcohol consumption and level of risk of psychological distress (except where risk of psychological distress was the outcome). Adjusted OR’s and 95% CI’s are reported and the Wald test used to assess statistical significance. Given the multiple comparisons and the high power to detect very small associations we used a significance level of \(p<0.01\), and considered a 50% increase/decrease in odds (i.e., ORs ≥1.5 or ≤0.67) to be of public health importance \[45\].

Results

The mean age of participants was 62.6 years and 55% of participants were female (Table 1), with 44.5% of the sample spending greater than 6 hours per day sitting.

Factors associated with higher sitting time

Odds of sitting time was significantly associated with: being male (all respondents/heart disease/cancer sub-samples), older age (all respondents/all sub-samples), high levels of education (all respondents/all sub-samples), being unmarried/partnered (all respondents/heart disease/cancer/psychological distress sub-samples), working fulltime (all respondents/all sub-samples), non-urban living (all respondents/all sub-samples), higher income levels (all respondents/all sub-samples), obesity (all respondents), comorbidities (all respondents/psychological distress sub-sample), physical limitations (all respondents/all sub-samples), poor self-rated health (all respondents/all sub-samples), no physical activity (all respondents/all sub-samples), being an ex-smoker (all respondents), and no alcohol consumption (heart disease sub-sample).
Table 1. Distribution of demographic, clinical and health behaviour characteristics for total sample, and by gender (N = 266,826).

| Demographic | Male % | Female % | Total % |
|-------------|-------|----------|---------|
| **Age**     |       |          |         |
| 45–54 years | 25.3  | 32.4     | 29.1    |
| 55–64 years | 31.6  | 32.7     | 32.2    |
| 65–74 years | 23.9  | 19.9     | 21.8    |
| 75+ years   | 19.2  | 15.0     | 16.9    |
| **Education** |       |          |         |
| up to year 10 | 26.4 | 41.1     | 34.3    |
| HSC/Tafe/Diploma | 48.3 | 37.0   | 42.3    |
| Degree or Higher | 25.3 | 21.9   | 23.4    |
| **Marital Status** |       |          |         |
| Single/Widowed/Divorce | 19.1 | 29.8   | 24.9    |
| Married/Defacto/partn | 80.9 | 70.2   | 75.1    |
| **Work Status** |       |          |         |
| Not working | 49.9  | 54.0     | 52.1    |
| Work p/t | 12.8  | 24.3     | 19.0    |
| Work f/t | 37.3  | 21.8     | 29.0    |
| **Urban/Non-urban** |       |          |         |
| Non-urban | 46.2  | 44.1     | 45.1    |
| Urban | 53.8  | 55.9     | 54.9    |
| **Income** |       |          |         |
| <$10,000 | 4.9   | 6.2      | 5.6     |
| $10,000–$29,999 | 23.8 | 23.6    | 23.7    |
| $30,000–$69,999 | 27.5 | 23.9    | 25.6    |
| >$70,000 | 27.7  | 19.9     | 23.5    |
| Missing | 16.2  | 26.4     | 21.7    |
| **Clinical** |       |          |         |
| Heart Disease |       |          |         |
| Yes | 16.2  | 8.2      | 11.9    |
| Cancer |       |          |         |
| Yes | 17.3  | 15.0     | 16.0    |
| Diabetes |       |          |         |
| Yes | 11.0  | 7.3      | 9.0     |
| BMI |       |          |         |
| <18.5 underweight | 0.6 | 1.6      | 1.2     |
| 18.5–<25—normal | 28.8 | 38.6    | 34.1    |
| 25–30—overweight | 44.0 | 30.1    | 36.5    |
| 30+ obese | 20.1  | 21.0     | 20.6    |
| Missing | 6.5  | 8.7      | 7.7     |
| Co-morbidities |       |          |         |
| Total score—Mean (SD) (range 0–5) | .45 (.68) | .40 (.64) | .43 (.66) |
| Physical functioning—SF10 |       |          |         |
| No limitation | 30.3 | 29.2     | 29.7    |
| Minor limitation | 16.6 | 13.2    | 14.8    |
| Mild limitation | 18.0 | 15.4    | 16.6    |
| Moderate limitation | 14.2 | 15.7    | 15.0    |

(Continued)
The following factors were significantly associated with higher sitting time based on our meaningful effect size (OR ≥ 1.5): **high income** ≥ $70,000 (whole sample OR = 1.70, 95% CI 1.63–1.78; heart disease subsample OR = 1.89, 95% CI 1.66–2.15; cancer subsample OR = 1.53, 95% CI 1.37–1.71; diabetes subsample OR = 1.86, 95% CI 1.61–2.16; psychological distress subsample OR = 1.73, 95% CI 1.58–1.90); **full-time work** (whole sample OR = 1.90, 95% CI 1.84–1.95; heart disease subsample OR = 1.65, 95% CI 1.50–1.81; cancer subsample OR = 1.87, 95% CI 1.74–2.01; diabetes subsample OR = 1.75, 95% CI 1.58–1.94; psychological distress subsample OR = 1.80, 95% CI 1.70–1.91) and **severe physical limitations** (whole sample OR = 1.63, 95% CI 1.57–1.69; heart disease subsample OR = 1.63, 95% CI 1.46–1.82; cancer subsample OR = 1.65, 95% CI 1.51–1.80; diabetes subsample OR = 1.57, 95% CI 1.40–1.76) (see Table 2).
Table 2. Adjusted odds ratios (AOR) with 95% confidence intervals for sitting more than six hours per day for all respondents, respondents who have: ever had heart disease; ever had cancer, ever had diabetes (not further defined); and those at moderate or high risk of psychological distress on the Kessler 10.

| Variable (reference category) | All Respondents n = 227,187 | Heart Disease Subsample n = 26,599 | Cancer Subsample n = 36,381 | Diabetes (NFD) Subsample n = 19,550 | Psychological Distress Subsample n = 48,334 |
|-----------------------------|-------------------------------|-------------------------------------|-------------------------------|--------------------------------------|--------------------------------------------|
| **Sex (Male)**              |                               |                                     |                               |                                      |                                            |
| Female                      | 0.95** (0.93, 0.96)           | 0.90** (0.85, 0.96)                 | 0.90** (0.86, 0.94)           | 0.96 (0.90, 1.03)                    | 0.95 (0.92, 0.99)                          |
| Age (45–54 years)           |                               |                                     |                               |                                      |                                            |
| 55–64 years                 | 1.05** (1.02, 1.07)           | 1.05 (0.95, 1.16)                   | 1.07 (1.00, 1.15)             | 1.10 (1.00, 1.21)                    | 1.04 (1.00, 1.09)                          |
| 65–74 years                 | 1.09** (1.05, 1.12)           | 1.08 (0.97, 1.21)                   | 1.05 (0.97, 1.13)             | 1.04 (0.94, 1.16)                    | 1.05 (0.99, 1.12)                          |
| 75+ years                   | 1.28** (1.24, 1.33)           | 1.23** (1.10, 1.38)                 | 1.24** (1.13, 1.35)           | 1.19* (1.05, 1.34)                   | 1.36** (1.26, 1.46)                        |
| **Education (Up to year 10)** |                               |                                     |                               |                                      |                                            |
| HSC/TAFE/Diploma            | 1.02 (1.00, 1.04)             | 1.05 (0.99, 1.11)                   | 1.04 (0.99, 1.09)             | 1.05 (0.99, 1.12)                    | 1.02 (0.97, 1.06)                          |
| Degree or Higher            | 1.36** (1.33, 1.40)           | 1.33** (1.23, 1.43)                 | 1.31** (1.23, 1.40)           | 1.38** (1.25, 1.51)                   | 1.33** (1.25, 1.40)                        |
| **Marital Status**          |                               |                                     |                               |                                      |                                            |
| Married/Defacto/Partner      | 0.86** (0.84, 0.87)           | 0.85** (0.80, 0.90)                 | 0.84** (0.80, 0.89)           | 0.89* (0.83, 0.95)                    | 0.82** (0.79, 0.86)                        |
| Work status (Not working)   |                               |                                     |                               |                                      |                                            |
| Work part time              | 1.09** (1.06, 1.11)           | 1.09 (1.00, 1.18)                   | 1.07 (1.00, 1.14)             | 1.04 (0.95, 1.15)                    | 1.07 (1.01, 1.13)                          |
| Work full time              | 1.90** (1.84, 1.95)           | 1.65** (1.5, 1.81)                  | 1.87** (1.74, 2.01)           | 1.75** (1.58, 1.94)                   | 1.80** (1.70, 1.91)                        |
| **Urban/Non-urban**         |                               |                                     |                               |                                      |                                            |
| Urban                       | 0.79** (0.78, 0.81)           | 0.85** (0.81, 0.89)                 | 0.81** (0.78, 0.85)           | 0.86** (0.81, 0.91)                   | 0.84** (0.81, 0.87)                        |
| Income (< $10,000)          |                               |                                     |                               |                                      |                                            |
| $10,000 - $29,999           | 1.14** (1.09, 1.19)           | 1.23** (1.11, 1.36)                 | 1.11 (1.01, 1.22)             | 1.22** (1.09, 1.36)                   | 1.15** (1.06, 1.24)                        |
| $30,000 - $69,999           | 1.15** (1.10, 1.20)           | 1.17* (1.05, 1.30)                  | 1.07 (0.97, 1.18)             | 1.21* (1.07, 1.37)                    | 1.10 (1.01, 1.19)                          |
| $70,000+                    | 1.70** (1.63, 1.78)           | 1.89** (1.66, 2.15)                 | 1.53** (1.37, 1.71)           | 1.86** (1.61, 2.16)                   | 1.73** (1.58, 1.9)                         |

(Continued)
Table 2. (Continued)

| Variable (reference category) | All Respondents n = 227,187 | Heart Disease Subsample n = 26,599 | Cancer Subsample n = 36,381 | Diabetes (NFD) Subsample n = 19,550 | Psychological Distress Subsample n = 48,334 |
|------------------------------|-----------------------------|-----------------------------------|-------------------------------|-------------------------------------|---------------------------------------------|
|                              | AOR 95% CI  | p value | AOR 95% CI  | p value | AOR 95% CI  | p value | AOR 95% CI  | p value | AOR 95% CI  | p value |
| Income missing               | 1.02 (0.97, 1.06) | p<.001  | 1.03 (0.92, 1.15) | p = .028 | 1.01 (0.92, 1.12) | p<.001  | 1.00 (0.89, 1.13) | p = .006  | 1.00 (0.92, 1.09) | p<.001  |
| BMI (<18.5 underweight)      |                            |        |                            |        |                            |        |                            |        |                            |        |
| 18.5<25—normal               | 1.02 (0.93, 1.10) | p<.001  | 0.77 (0.61, 0.97) | p = .087 | 1.06 (0.87, 1.29) | p<.001  | 0.84 (0.57, 1.25) | p = .006  | 1.01 (0.86, 1.18) | p<.001  |
| 25<30—overweight             | 1.09 (1.00, 1.18) | p = .028 | 0.81 (0.64, 1.01) | p = .028 | 1.12 (0.92, 1.36) | p<.001  | 0.84 (0.57, 1.24) | p = .006  | 1.11 (0.95, 1.3) | p<.001  |
| 30+ obese                     | 1.21** (1.11, 1.31) | p = .006 | 0.85 (0.67, 1.07) | p = .006 | 1.20 (0.99, 1.46) | p<.001  | 0.95 (0.64, 1.41) | p = .006  | 1.24 (1.05, 1.45) | p<.001  |
| Missing                       | 1.03 (0.94, 1.13) | p<.001  | 0.81 (0.63, 1.03) | p = .006 | 1.03 (0.83, 1.26) | p<.001  | 0.92 (0.62, 1.38) | p = .006  | 1.10 (0.93, 1.31) | p<.001  |
| Comorbidities                 | 1.03** (1.02, 1.05) | p<.001  | 0.99 (0.95, 1.03) | p = .059 | 0.99 (0.96, 1.03) | p<.001  | 1.01 (0.97, 1.05) | p = .067  | 1.06** (1.04, 1.09) | p<.001  |
| SF10 (No limitation)          |                            |        |                            |        |                            |        |                            |        |                            |        |
| Minor limitation              | 1.07** (1.05, 1.10) | p<.001  | 1.07 (0.96, 1.19) | p = .006 | 1.06 (0.98, 1.14) | p<.001  | 1.03 (0.92, 1.15) | p = .006  | 0.99 (0.93, 1.06) | p<.001  |
| Mild limitation               | 1.14** (1.11, 1.17) | p = .006 | 1.18* (1.07, 1.30) | p = .006 | 1.10 (1.02, 1.18) | p<.001  | 1.16* (1.04, 1.28) | p = .006  | 1.03 (0.97, 1.10) | p<.001  |
| Mod limitation                | 1.23** (1.19, 1.27) | p<.001  | 1.27** (1.15, 1.4) | p<.001  | 1.25** (1.16, 1.34) | p<.001  | 1.27** (1.14, 1.41) | p<.001  | 1.08 (1.01, 1.15) | p<.001  |
| Severe limitation             | 1.63** (1.57, 1.69) | p<.001  | 1.63** (1.46, 1.82) | p<.001  | 1.65** (1.51, 1.80) | p<.001  | 1.57** (1.40, 1.76) | p<.001  | 1.44** (1.34, 1.54) | p<.001  |
| Missing                       | 0.88** (0.85, 0.92) | p<.001  | 0.94 (0.82, 1.07) | p = .006 | 0.97 (0.88, 1.07) | p<.001  | 0.93 (0.81, 1.07) | p = .006  | 0.85** (0.78, 0.93) | p<.001  |
| Self-rated Health             | 0.93** (0.92, 0.94) | p<.001  | 0.90** (0.87, 0.93) | p<.001  | 0.91** (0.89, 0.94) | p<.001  | 0.88** (0.84, 0.91) | p<.001  | 0.91** (0.89, 0.94) | p<.001  |
| PA (<1 min)                   |                            |        |                            |        |                            |        |                            |        |                            |        |
| 1–149 mins                    | 0.89** (0.86, 0.93) | p<.001  | 0.77** (0.69, 0.85) | p = .006 | 0.84** (0.77, 0.93) | p<.001  | 0.77** (0.69, 0.87) | p = .006  | 0.84** (0.78, 0.90) | p<.001  |
| 150–299 mins                  | 0.90** (0.87, 0.94) | p = .006 | 0.76** (0.68, 0.85) | p = .006 | 0.84* (0.76, 0.93) | p<.001  | 0.76** (0.68, 0.86) | p = .006  | 0.85** (0.78, 0.92) | p<.001  |
| 300+ mins                     | 0.73** (0.70, 0.76) | p<.001  | 0.61** (0.55, 0.87) | p<.001  | 0.69** (0.63, 0.76) | p<.001  | 0.62** (0.55, 0.69) | p<.001  | 0.66** (0.61, 0.71) | p<.001  |
| Smoking (Current smoker)      |                            |        |                            |        |                            |        |                            |        |                            |        |
| Ex-smoker                     | 1.07** (1.03, 1.11) | p<.001  | 0.95 (0.85, 1.08) | p<.001  | 0.98 (0.89, 1.08) | p<.001  | 0.98 (0.87, 1.10) | p = .012  | 1.06 (1.00, 1.13) | p<.001  |
| (Continued)
| Variable (reference category) | All Respondents n = 227,187 | Heart Disease Subsample n = 26,599 | Cancer Subsample n = 36,381 | Diabetes (NFD) Subsample n = 19,550 | Psychological Distress Subsample n = 48,334 |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
|                               | AOR 95% CI p value | AOR 95% CI p value | AOR 95% CI p value | AOR 95% CI p value | AOR 95% CI p value |
| Never smoked                  | 0.99 (0.96, 1.03) | 0.90 (0.80, 1.02) | 0.91 (0.83, 1.00) | 0.89 (0.79, 1.01) | 0.96 (0.91, 1.03) |
| Alcohol (0/<1/week)           | 1–7/week: 1.00 (0.98, 1.02) | 0.91* (0.86, 0.97) | 0.96 (0.91, 1.01) | 0.93 (0.87, 1.00) | 1.01 (0.96, 1.05) |
|                               | 8–14/week: 1.02 (1.00, 1.05) | 0.90* (0.83, 0.97) | 0.99 (0.92, 1.05) | 1.01 (0.92, 1.12) | 1.04 (0.98, 1.10) |
|                               | 15+/week: 0.99 (0.96, 1.02) | 0.90* (0.83, 0.97) | 0.93 (0.86, 0.99) | 1.00 (0.9, 1.11) | 1.05 (0.99, 1.12) |
| Psychological Distress (No/low risk) | p<.001 | p<.001 | p<.001 | p<.001 |
| Medium risk                   | 1.03 (1.00, 1.06) | 1.09 (1.01, 1.17) | 1.07 (1.00, 1.14) | 1.00 (0.92, 1.09) | n/a n/a |
| High risk                     | 1.05 (1.01, 1.09) | 1.05 (0.95, 1.16) | 1.09 (0.99, 1.19) | 0.99 (0.88, 1.10) | n/a n/a |
| Missing                       | 0.78** (0.76, 0.81) | 0.79** (0.73, 0.85) | 0.78** (0.73, 0.84) | 0.72** (0.66, 0.80) | n/a n/a |

Notes to table:
* p<.01  
** p<.001  
1 Overall test of significance (Wald test) for multiple category categorical variables  
NFD = no further definition  
bold denotes those groups that had an OR >1.5.
Discussion

Our study identified factors associated with sitting time in (i) general, (ii) chronic disease (heart disease/cancer/diabetes), and (iii) psychologically distressed population groups. To our knowledge, this is the first study to concurrently examine factors associated with sitting time in various at-risk population groups, in a large sample of adults aged ≥45 years. The mean sitting time (5.5 hours/day) in our sample was similar to that of a multi-country population-based European study [17].

Consistent with previous literature [46, 47], our study demonstrates that females were less likely than males to sit for greater than 6 hours per day, in the overall, heart disease and cancer samples. Previous studies examining the association between sitting time and age have included younger age groups than those included in the current study. These studies found that younger age is associated with higher sitting time [15, 18]. In the current study, we found that older age was associated with higher sitting, compared to middle age.

Sitting time in our study was positively associated with higher education in all analyses. In a recent systematic review, the type of sedentary behavior engaged in was an important factor [10], with both television viewing and computer use associated with years of education (albeit in opposite directions), yet overall sitting time was not associated with education level. In all analyses, being married was negatively associated with sitting time. This may be attributable to differences in leisure activities such as television viewing, between married and unmarried individuals. Previous research has demonstrated both positive [48] and negative [8, 49, 50] associations between marital status and television viewing.

The negative association between sitting time and urban location found for all samples is supported by Clark and colleagues [51] who reported that ≥2 hours of television viewing per day was associated with living outside of state capital cities, which may be attributed to environmental factors, such as urban residents having more active travel options and amenities within walking distance, which could result in a reduction of sitting [52].

Obesity was positively associated with high sitting time for the overall sample, as has been found previously for television viewing time [19]. However due to the cross-sectional nature of our study, it is unknown whether high sitting time results in a higher BMI or if those with a higher BMI sit more [20, 53, 54]. Longitudinal studies are required to further investigate the direction of the relationship between sitting time and obesity.

Our study appears to be the first to examine the association between chronic disease co-morbidities and sitting time. We found that sitting time was positively associated with chronic disease co-morbidities for the overall and the psychological distress subsample, and negatively associated with self-rated health in all samples, consistent with previous research which demonstrated that television viewing was associated with reduced well-being [10], dissatisfaction with personal life and poorer self-perceived health [7].

In our study more physical activity was associated with lower odds of high sitting time, as previously demonstrated in numerous studies [46, 55, 56]. This highlights the need for interventions that focus on the pattern of physical activity, promoting both increases in physical activity and reductions in prolonged sitting. This might best be achieved by encouraging adults to engage in light intensity activity as well as MVPA, since research shows that adults are more likely to replace sitting behaviors with light intensity activity [57].

High sitting time was positively associated with smoking for the overall sample; a previous review reported mixed findings for the association between smoking and television viewing/general sedentary behavior [10]. In the current study, alcohol consumption was not associated with sitting time which is consistent with most previous findings [19, 58–60]. Interestingly, however, higher alcohol consumption was associated with lower odds of higher sitting time for
the heart disease subsample only. It may be that those with heart disease receive more emphasis on physical activity participation and reduced sitting time as a standard part of recovery.

Interestingly, sitting time was not significantly associated with psychological distress, in contrast to previous literature which has identified an association between high levels of sedentary behaviour and greater odds of depression [21, 61]. The K10 assesses psychological distress, rather than depression, which may explain the lack of significance found between psychological distress and sitting time within this study. It may be that factors such as low self-esteem, lack of motivation, feelings of hopelessness and fatigue, which were not examined in our study, may moderate this association [21].

Based on our clinically important effect size of OR≥1.5, high income ≥$70,000 (all respondents/all subsamples), full-time work (all respondents/all subsamples), and severe physical limitations (all respondents/ heart disease/cancer/diabetes subsamples), appear to be associated with highest odds of higher sitting time. Higher sitting time was positively associated with high income categories, which has been previously reported [10]. Evidence suggests that individuals employed in sedentary occupations may also engage in sedentary leisure time activities [62–66].

Higher sitting time was positively associated with full-time work for all subsamples in the current study. Previous literature suggests that individuals who are employed have greater odds of sitting in comparison to those who are unemployed; however sitting time is likely to be influenced by the type of work an individual is involved in [18]. High sedentary time for those in full-time employment is not surprising, considering that the majority of this sedentary time occurs at work [6, 67, 68]. In addition, evidence suggests a positive relationship between unemployment and increased hours of TV also exists [69–72].

Higher sitting time was positively associated with all physical limitation categories (minor to severe), suggesting that odds of sitting time may increase with physical limitation severity; and has been previously demonstrated in cancer [73] and diabetes [16] populations.

We completed a sensitivity analysis using both 7 and 8-hours as cut-points for high sitting time. These results for the 7 and 8-hour cut-points were consistent with all of the 6 hour cut points and OR’s remained at the same level of significance (p<0.001) for each of the study groups for income, hours of full-time work and severe limitations. The OR’s for income within each study group were similar for all three (6, 7 and 8-hour) cut points, while there was a monotonic increase in OR’s for hours of full-time work and severe limitations for the three cut-points.

**Limitations and conclusions**

Some study limitations should be acknowledged. First, the cross-sectional nature of the study does not allow the direction of relationships to be determined. While this study may help to identify which chronic disease groups to target, we cannot distinguish which approaches would be most appropriate for each group. Second, self-report measures were used to assess clinical and behavioral variables. Adults tend to under-report body weight [74] and alcohol behavior [75]. Further, the use of a single-item, subjective assessment of sitting time limits the sensitivity/specificity of assessing this behavior, which may have led to under-reporting. To limit response burden in this general health survey, the inclusion of multiple items or objective methods to assess sedentary behavior was not possible. Moreover, light intensity physical activity is difficult to adequately assess with a questionnaire and it may be a modifier of the associations reported in this study. Future studies should employ objective measures where possible for assessing sitting behavior and physical activity and more specific questions including information on domain specific types of sedentary behaviour would also be useful. Third, diabetes
type was not differentiated in the questionnaire (e.g., Type 1 or 2), which is important for tailoring interventions.

This study extends the current literature concerning factors associated with high sitting in adults, and appears to be the largest population study to date to examine factors associated with sitting time in both chronic disease (i.e., heart disease, cancer, diabetes) and psychological distress (i.e., anxiety, depression) populations. The identification of key factors from this study may assist to inform the development of future studies using more sophisticated measurement procedures and longitudinal designs to ultimately guide health promotion practice to reduce sitting time. It may be particularly important to target high-income, full-time workers and those with severe physical limitations as higher sitting time appears to be substantial in general, chronic disease, and psychologically distressed, adult populations. Future studies are encouraged to examine health effects associated with both duration and type of sedentary behavior, using validated and objective measures, and to undertake longitudinal studies to investigate causal relationships.

Supporting Information
S1 Data. Datasets used to manipulate data and create derived variables and indices. (ZIP)

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Author Contributions
Conceived and designed the experiments: RP SC CS AG EJ NJ AB CD HP. Analyzed the data: AG RP. Wrote the paper: RP SC CS AG EJ NJ AB CD HP RR.

References
1. Haskell WL, Lee I-M, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007; 116(9):1081. PMID: 17671237
2. Healy G, Dunstan D, Salmon J, Cerin E, Shaw J, Zimmet P, et al. Breaks in Sedentary Time Beneficial associations with metabolic risk. Diabetes Care. 2008; 31(4):661–6. doi:10.2337/dc07-2046 PMID: 18252901
3. Owen N, Healy GN, Matthews CE, Dunstan DW. Too Much Sitting: The Population Health Science of Sedentary Behavior. Exerc Sport Sci Rev. 2010; 38(3):105–13. doi:10.1097/JES.0b013e3181e73a2 PMID: 20577058
4. Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. Int J Obes Relat Metab Disord. 2005; 29(S2):S84–S96. doi:10.1038/sj.ijo.0802668
5. Crawford D, Jeffery R, French S. Television viewing, physical inactivity and obesity. Int J Obes Relat Metab Disord. 1999; 23(4). doi: 10.1038/sj.ijo.0800845 PMID: 10340812
6. Thorp AA, Owen N, Neuhaus M, Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996–2011. Am J Prev Med. 2011; 41(2):207–15. doi: 10.1016/j.amepre.2010.05.004 PMID: 21767729

7. McCreary DR, Sadava SW. Television Viewing and Self-Perceived Health, Weight, and Physical Fitness: Evidence for the Cultivation Hypothesis. Journal of Applied Social Psychology. 1999; 29(11):2342–61. doi: 10.1111/1559-1816.1999.tb00114.x

8. Ekelund U, Brage S, Besson H, Sharp S, Wareham NJ. Time spent being sedentary and weight gain in healthy adults: reverse or bidirectional causality? The American Journal of Clinical Nutrition [Internet]. 2008 September 1, 2008; 88(3):612–7 pp. Available from: http://ajcn.nutrition.org/content/88/3/612.short.

9. Swartz AM, Squires L, Strath SJ. Energy expenditure of interruptions to sedentary behavior. Int J Behav Nutr Phys Act. 2011; 8(69):10.1186. doi: 10.1186/1479-5868-8-69

10. Rhodes RE, Mark RS, Temmel CP. Adult sedentary behavior: a systematic review. Am J Prev Med. 2012; 42(3):e3–e28. doi: 10.1016/j.amepre.2011.10.020 PMID: 22341176

11. Proper KI, Singh AS, Van Mechelen W, Chinapaw MJ. Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. Am J Prev Med. 2011; 40(2):174–82. doi: 10.1016/j.amepre.2010.10.015 PMID: 21238866

12. Sloan RA, Sawada SS, Girdano D, Liu YT, Biddle SJ, Blair SN. Associations of sedentary behavior and physical activity with psychological distress: a cross-sectional study from Singapore. BMC Public Health. 2013; 13(1):885. doi: 10.1186/1471-2458-13-885

13. Australian Bureau of Statistics. Australian Idle: Physical Activity and Sedentary Behaviour of Adult Australians Canberra2013 Available: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4156.0.55.001Main+Features4Nov%202013. Accessed 04 February 2013.

14. Clark B, Peeters G, Gomersall S, Pavey T, Brown W. Nine year changes in sitting time in young and mid-aged Australian women: Findings from the Australian Longitudinal Study for Women's Health. Prev Med. 2014; 64:1–7. doi: 10.1016/j.jpmed.2014.03.017 PMID: 24657548

15. Bauman A, Ainsworth BE, Sallis JF, Hagströmer M, Craig CL, Bull FC, et al. The Descriptive Epidemiology of Sitting: A 20-Country Comparison Using the International Physical Activity Questionnaire (IPAQ). Am J Prev Med. 2011; 41(2):228–35 doi: 10.1016/j.amepre.2011.05.003 PMID: 21767731

16. Healy GN, Wijndaele K, Dunstan DW, Shaw JE, Salmon J, Zimmet PZ, et al. Objectively Measured Sedentary Time, Physical Activity, and Metabolic Risk: The Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Diabetes Care. 2008; 31(2):369–71. doi: 10.2337/dc07-1795 PMID: 18001811

17. Bennie JA, Chau JY, van der Ploeg HP, Stamatakis E, Do A, Bauman A. The prevalence and correlates of sitting in European adults—a comparison of 32 Eurobarometer-participating countries. Int J Behav Nutr Phys Act. 2013; 10(1):107. doi: 10.1186/1479-5868-10-107

18. Van Dyck D, Cardon G, Deforche B, Owen N, Sallis JF, De Bourdeaudhuji I. Neighborhood Walkability and Sedentary Time in Belgian Adults. Am J Prev Med. 2010; 39(1):25–32. doi: 10.1016/j.amepre.2010.03.004 PMID: 20547277

19. King AC, Goldberg JH, Salmon J, Owen N, Dunstan D, Weber D, et al. Identifying Subgroups of U.S. Adults at Risk for Prolonged Television Viewing to Inform Program Development. Am J Prev Med. 2010. doi: 10.1016/j.amepre.2009.08.032 PMID: 2017553

20. Chau JY, van der Ploeg HP, Merom D, Chey T, Bauman AE. Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. Prev Med. 2012; 54(3–4):195–200. doi: 10.1016/j.jpmed.2011.12.020

21. Arredondo EM, Mendelson T, Elder JP, Marshall SJ, Flair LL, Ayala GX. The relation of medical conditions to depressive symptoms among Latinos: Leisure time physical activity as a mediator. Journal of Health Psychology. 2012; 17(5):742–52. doi: 10.1177/1359105311424468 PMID: 22021277

22. Rhodes RE, Blanchard CM. Just how special are the physical activity cognitions in diseased populations? Preliminary evidence for integrated content in chronic disease prevention and rehabilitation. Ann Behav Med. 2007; 33(3):302–11. doi: 10.1007/BF02879912 PMID: 17600457

23. Banks E, Redman S, Jorm L, Armstrong B, Bauman A, Beard J, et al. Cohort profile: the 45 and up study. Int J Epidemiol. 2008; 37(5):941–7. doi: 10.1093/ije/dyn184 PMID: 17881411

24. George ES, Rosenkranz RR, Kolt GS. Chronic disease and sitting time in middle-aged Australian males: findings from the 45 and Up Study. Int J Behav Nutr Phys Act. 2013; 10(1):20. doi: 10.1186/1479-5868-10-20 PMID: 23281722

25. Craig CL, Marshall A, Sjostrom M, Bauman A, Booth M, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003; 195(9131/03):3508–1381. doi: 10.1249/01.MSS.0000078924.61453.FB
26. Healy GN, Clark BK, Winkler EAH, Gardiner PA, Brown WJ, Matthews CE. Measurement of Adults' Sedentary Time in Population-Based Studies. Am J Prev Med. 2011; 41(2):216–27. doi: 10.1016/j.amepre.2011.05.005 PMID: 21767730

27. Chau JY, Grunseit AC, Chey T, Stamatakis E, Brown WJ, Matthews CE, et al. Daily sitting time and all-cause mortality: a meta-analysis. PLOS ONE. 2013; 8(11):e80000. doi: 10.1371/journal.pone.0080000 PMID: 24236168

28. van der Ploeg HP, Chey T, Korda RJ, Banks E, Bauman A. Sitting time and all-cause mortality risk in 222 497 Australian adults. Arch Intern Med. 2012; 172(6):494. doi: 10.1001/archinternmed.2011.2174 PMID: 22450936

29. Staiano A, Harrington D, Barreira T, Katzmarzyk P. Sitting time and cardiometabolic risk in US adults: associations by sex, race, socioeconomic status and activity level. Br J Sports Med. 2014; 48(3):213–9. doi: 10.1136/bjsports-2012-091896 PMID: 23981954

30. Petersen CB, Bauman A, Grønbæk M, Helge JW, Thygesen LC, Tolstrup JS. Total sitting time and all-cause mortality in a prospective cohort of Danish adults. Int J Behav Nutr Phys Act. 2014; 11(1):13.

31. Australian Institute of Health and Welfare. Remote Health: A Guide to Remoteness Classifications Canberra2004.

32. Villanueva EV. The validity of self-reported weight in US adults: a population based cross-sectional study. BMC Public Health. 2001; 1(1):11. doi: 10.1186/1471-2458-1-11

33. Ware JEJ, Sherbourne CD. The MOS 36-item Short-Form Health Survey (SF-36): I. Conceptual Framework and Item Selection. Med Care. 1992; 30(6):473–83. PMID: 1593914

34. George ES, Jorm L, Kolt GS, Bambrick H, Lujic S. Physical activity and psychological distress in older men: findings from the New South Wales 45 and up study. J Aging Phys Act. 2012; 20(3):300–16. PMID: 22186701

35. Timperio A, Cameron-Smith D, Burns C, Salmon J, Crawford D. Physical activity beliefs and behaviours among adults attempting weight control. International journal of obesity and related metabolic disorders; journal of the International Association for the Study of Obesity. 2000; 24(1):81–7. doi: 10.1038/sj.ijo.0801089

36. Timperio A, Salmon J, Crawford D. Validity and reliability of a physical activity recall instrument among overweight and non-overweight men and women. J Sci Med Sport. 2003; 6(4):477–91. doi: 10.1016/S1440-2440(03)80273-6 PMID: 14723397

37. Brown W, Trost S, Bauman A, Mummery K, Owen N. Test-retest reliability of four physical activity measures used in population surveys. J Sci Med Sport. 2004; 7(2):205–15. doi: 10.1016/S1440-2440(03)80010-0 PMID: 15362316

38. World Health Organisation. Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks. 2009.

39. Department of Health. Australia’s Physical Activity & Sedentary Behaviour Guidelines for Adults Canberra2014. Available: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines.

40. Magee CA, Iverson DC, Caputi P. Factors associated with short and long sleep. Prev Med. 2009; 49(6):461–7. doi: 10.1016/j.ypmed.2009.10.006 PMID: 19850073

41. Kessler RC, Andrews G, Colpe LJ. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychological Med 2002; 32:959–76. doi: 10.1017/S0033291702006074

42. Andrews G, Slade T. Interpreting scores on the Kessler psychological distress scale (K10). Aust N Z J Public Health. 2001; 25(6):494–7. doi: 10.1111/j.1467-842X.2001.tb00310.x/full PMID: 11824981

43. Health Outcomes Assessment Unit—Epidemiology and Analytical Services Health Information Centre. Collaborative Health & Wellbeing Survey: Design and Methodology. 2001.

44. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ. 2009; 338:b2393. doi: 10.1136/bmj.b2393 PMID: 19564179

45. Chen H, Cohen P, Chen S. How big is a big odds ratio? Interpreting the magnitudes of odds ratios in epidemiological studies. Communications in Statistics—Simulation and Computation. 2010; 39(4):860–4. doi: 10.1080/036109101000350383

46. Gao X, Nelson ME, Tucker KL. Television Viewing Is Associated With Prevalence of Metabolic Syndrome in Hispanic Elders. Diabetes Care. 2007; 30(3):694–700. doi: 10.2337/dc06-1835 PMID: 17327343

47. Van Dyck D, Cerin E, Conway TL, De Bourdeaudhuij I, Owen N, Kerr J, et al. Associations between perceived neighborhood environmental attributes and adults' sedentary behavior: Findings from the USA,
Australia and Belgium. Soc Sci Med. 2012; 74(9):1375–84. doi: org/10.1016/j.socscimed.2012.01.018.

48. Richmond TK, Walls CE, Gooding HC, Field AE. Television viewing is not predictive of BMI in Black and Hispanic young adult females. Obesity (Silver Spring, Md). 2010; 18(5):1015–20. doi: 10.1038/oby.2009.391 PMID: 19876003

49. Coakley EH, Rimm EB, Colditz G, Kawachi I, Willett W. Predictors of weight change in men: results from the Health Professionals Follow-up Study. Int J Obes Relat Metab Disord. 1998; 22(2):89–96. doi: 10.1038/sj.ijo.0800549 PMID: 9504316

50. Kronenberg F, Pereira MA, Schmitz MKH, Arnett DK, Evenson KR, Crapo RO, et al. Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI Family Heart Study. Atherosclerosis. 2000; 153(2):433–43. doi: 10.1016/S0021-9150(00)00426-3 PMID: 11164433

51. Clark BK, Sugiyama T, Healy GN, Salmon J, Dunstan DW, Shaw JE, et al. Socio-demographic correlates of prolonged television viewing time in Australian men and women: the AusDiab study. J Phys Act Health. 2010; 7(5):595–601. PMID: 20864754.; PubMed Central PMCID: PMC20864754.

52. Sugiyama T, Salmon J, Dunstan DW, Bauman AE, Owen N. Neighborhood walkability and TV viewing time among Australian adults. Am J Prev Med. 2007; 33(6):444–9. doi: 10.1016/j.amepre.2007.07.035 PMID: 18022059

53. de Heer HD, Wilkinson AV, Strong LL, Bondy ML, Koehly LM. Sitting time and health outcomes among Mexican origin adults: obesity as a mediator. BMC Public Health. 2012; 12(1):896. doi: 10.1186/1471-2458-12-896

54. Pedisic Z, Grunseit A, Ding D, Chau JY, Banks E, Stamatakis E, et al. High sitting time or obesity: Which came first? Bidirectional association in a longitudinal study of 31,787 Australian adults. Obesity. 2014; 22(10):2126–30. doi: 10.1002/oby.20817 PMID: 24940307

55. Berry B. Disparities in free time inactivity in the United States: Trends and explanations. Sociological Perspectives. 2007; 50(2):177–208. doi: 10.1525/sop.2007.50.2.177

56. Touvier M, Cherbut C, Charreire H, Vergnaud A-C, Hercberg S, Oppert J-M. Changes in leisure-time physical activity and sedentary behaviour at retirement: a prospective study in middle-aged French subjects. Int J Behav Nutr Phys Act. 2010; 7:14. doi: 10.1186/1479-5868-7-14 PMID: 20181088

57. Owen N, Bauman A, Brown W. Too much sitting: a novel and important predictor of chronic disease risk? Br J Sports Med. 2009; 43(2):81–3. doi: 10.1136/bjsm.2008.055269 PMID: 19050003

58. Hu FB, Leitzmann MF, Stampfer MJ, Colditz GA, Willett WC, Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med. 2001; 161(12):1542–8. doi: 10.1001/archinte.161.12.1542 PMID: 11427103

59. Shields M, Tremblay MS. Screen time among Canadian adults: a profile. Statistics Canada; 2008 0840–6529 (Print); 0840–6529 (Linking) Contract No.: 2.

60. Rhodes RE, Dean RN. Understanding Physical Inactivity: Prediction of Four Sedentary Leisure Behaviors. Leisure Sciences. 2009; 31(2):124–35. doi: 10.1080/01490400802685948

61. Teychenne M, Ball K, Salmon J. Sedentary Behavior and Depression Among Adults: A Review. IntJ Behav Med. 2010; 17(4):246–54. doi: 10.1007/s12529-010-9075-z

62. Fox K, Hillsdon M. Physical activity and obesity. Obes Rev. 2007; 8(s1):115–21. doi: 10.1111/j.1467-789X.2007.00329.x

63. Jans MP, Proper KI, Hildebrandt VH. Sedentary behavior in Dutch workers: differences between occupations and business sectors. Am J Prev Med. 2007; 33(6):450–4. doi: 10.1016/j.amepre.2007.07.033 PMID: 18022060

64. Parsons T, Thomas C, Power C. Estimated activity patterns in British 45 year olds: cross-sectional findings from the 1958 British birth cohort. Eur J Clin Nutr. 2009; 63(8):978–85. doi: 10.1038/seatn.2009.6 PMID: 19223916

65. Wolin KY, Bennett GG. Intercorrelations of socioeconomic position and occupational and leisure-time physical activity in the National Health and Nutrition Examination Survey. J Phys Act Health. 2008; 5(2):229. PMID: 19362032

66. Tigbe WW, Lean ME, Granat MH. A physically active occupation does not result in compensatory inactivity during out-of-work hours. Prev Med. 2011; 53(1):48–52. doi: 10.1016/j.pmed.2011.04.018

67. Brown W, Miller Y, Miller R. Sitting time and work patterns as indicators of overweight and obesity in Australian adults. Int J Obes. 2003; 27(11):1340–6. doi: 10.1038/sj.ijo.0802426 PMID: 14574344

68. Bureau of Labor Statistics. American Time Use Survey Washington 2013. Available: http://www.bls.gov/tus/charts/.

69. Salmon J, Bauman A, Crawford D, Timperio A, Owen N. The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity.
70. Bowman SA. Television-Viewing Characteristics of Adults: Correlations to Eating Practices and Overweight and Health Status. Prev Chronic Dis. 2006; 3(2). Available: http://www.cdc.gov/pcd/issues/2006/apr/05_0139.htm.

71. Shields M, Tremblay MS. Sedentary behaviour and obesity. Statistics Canada; 2008 Contract No.: 2.

72. Clark BK, Healy GN, Winkler E, Gardiner PA, Sugiyama T, Dunstan DW, et al. Relationship of television time with accelerometer-derived sedentary time: NHANES. Med Sci Sports Exerc. 2011; 43(5):822–8. doi: 10.1249/MSS.0b013e3182019510 PMID: 20980928

73. Zhang M, Xie X, Lee AH, Binns CW. Sedentary behaviours and epithelial ovarian cancer risk. Cancer Causes Control. 2004; 15(1):83–9. doi: 10.1023/B:CACO.0000016633.47025.2a PMID: 14970738

74. Stommel M, Schoenborn CA. Accuracy and usefulness of BMI measures based on self-reported weight and height: findings from the NHANES & NHIS 2001–2006. BMC Public Health. 2009; 9(1):421.

75. Bellis M, Hughes K, Cook P, Morleo M. Off measure: how we underestimate the amount we drink. Alcohol Concern, London. 2009.
