Associations of television viewing time and overall sitting time with the metabolic syndrome in older men and women: The AusDiab Study

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Funding Sources:

This work was supported by the National Health and Medical Research Council (NHMRC) (program grant #569940 to NO, postdoctoral fellowship #569861 to GH, #511001 to EE); the

National Heart Foundation (postgraduate scholarship #PP 06B 2889 to PG, postdoctoral fellowship #PH 08B 3905 to GH); Australian Federal Government (Australian postgraduate award to BC); Victorian Health Promotion (public health research fellowship to DD); and Queensland Health Core Research Infrastructure Grant.

The AusDiab study is co-coordinated by The Baker IDI Heart and Diabetes Institute, and gratefully acknowledges the generous support given by: Australian Government Department of Health and Ageing, Abbott Australasia Pty Ltd, Alphapharm Pty Ltd, AstraZeneca, Aventis Pharma, Bristol-Myers Squibb, City Health Centre-Diabetes Service-Canberra, Department of Health and Community Services-Northern Territory, Department of Health and Human Services – Tasmania. Department of Health – New South Wales, Department of Health – Western Australia, Department of Health – South Australia, Department of Human Services–Victoria, Diabetes Australia, Diabetes Australia Northern Territory, Eli Lilly Australia, Estate of the Late Edward Wilson, GlaxoSmithKline, Jack Brockhoff Foundation, Janssen-Cilag, Kidney Health Australia, Marian & FH Flack Trust, Menzies Research Institute, Merck Sharp & Dohme, Novartis Pharmaceuticals, Novo Nordisk Pharmaceuticals, Pfizer Pty Ltd, Pratt Foundation, Queensland Health, Roche Diagnostics Australia, Royal Prince Alfred Hospital, Sydney, Sanofi Synthelabo.

Running head: Sedentary behavior and metabolic syndrome

ABSTRACT

OBJECTIVES: To examine associations of self-reported television (TV) viewing time and overall sitting time with the metabolic syndrome and its components.

DESIGN: Cross-sectional.

SETTING: Population-based sample of older men and women living in Australia.

PARTICIPANTS: 1,958 participants from the Australian Diabetes Obesity and Lifestyle (AusDiab) study (aged ≥ 60 years, mean age 69, 54% women).

MEASUREMENTS: Self-reported TV viewing time and overall sitting time were collected by interviewer-administered questionnaire. The metabolic syndrome was defined according to the revised International Diabetes Federation criteria.

RESULTS: Compared to those in the lowest quartile, the OR (95% CI) of the metabolic syndrome for men and women in the highest quartile of TV viewing time were 1.42 (0.93-2.15) and 1.42 (1.01-2.01) respectively, and 1.57 (1.02-2.41) for men and 1.56 (1.09-2.24) for women in the highest quartile of overall sitting time. TV viewing time was associated with reduced high-density lipoprotein cholesterol (HDL-C) levels, and glucose intolerance in women only. Overall sitting time was detrimentally associated with an increased risk of raised triglyceride levels (men and women), abdominal obesity (women only), and reduced HDL-C levels (men only). All models were adjusted for age, education, physical activity, self-rated health, employment, diet, smoking, alcohol intake, and hormone replacement therapy / estrogen use (women only)

CONCLUSION: For older adults, high levels of sedentary behavior were associated with an increased prevalence of the metabolic syndrome; reducing prolonged overall sitting time may be a feasible way to improve their metabolic health.

Key words: metabolic syndrome – television viewing – sitting time – older adults

INTRODUCTION

The metabolic syndrome is a clustering of cardiovascular disease risk factors and its presence is predictive of type 2 diabetes and all-cause mortality (1, 2). Prevalence of the metabolic syndrome increases with age (3): in the USA, prevalence estimates of the metabolic syndrome are 59% for older adults [defined as those aged ≥ 60 years (4)]; compared to 33% for the general younger adult population [aged 20 – 59 years] (5).

Lifestyle factors such as lack of regular physical activity, poor nutrition, high alcohol consumption, and smoking are associated with an increased risk of having the metabolic syndrome (6). More recently, another lifestyle factor, sedentary behavior (too much sitting, as distinct from lack of exercise), has emerged as an important public health problem. In addition to being associated with an increased risk of the metabolic syndrome (7-11), sedentary behavior is associated with components of the metabolic syndrome, including higher waist circumference, elevated levels of triglycerides and fasting glucose, and lower high density lipoprotein-cholesterol (HDL-C) (8, 9, 11-14). All of these studies examined television (TV) viewing time, either alone or in conjunction with computer use as their measure of sedentary behavior.

In Australia, men and women aged 65 years and older watch TV for 3 hours 56 minutes and 3 hours 50 minutes, respectively; this is 56 minutes and one hour more than for men and women aged from 25 to 64 years respectively (15) While objectively-derived data on sedentary time are not available in the Australian population, it would be expected to be similar to the USA where older adults are more sedentary than their younger counterparts, with total daily objectively assessed sedentary time being 7.5 hours/day for those aged 20 to 59 years, and 8.9 hours for those 60 years and older (16). The relationships between sedentary behavior and the metabolic syndrome remains poorly understood in older adults, who are the most sedentary group in the population and who also have the highest metabolic

syndrome prevalence. Only one study has specifically examined associations of sedentary behavior with the metabolic syndrome in older adults, specifically Hispanic elders in the United States (17), reporting similar findings to those of the general adult population - high levels of TV viewing time were an independent risk factor for the metabolic syndrome. No evidence is available for older adults on the extent to which overall sitting time (inclusive of leisure-time, occupational and transport domains of sedentary behavior) is associated with the metabolic syndrome.

We examined the associations of TV viewing time and overall sitting time with the metabolic syndrome and its components among older participants in a large, population-based study of older adults living in Australia. Previous studies in the general adult population have observed stronger associations of sedentary behaviours (particularly TV viewing time) with the metabolic syndrome in women, compared to men (7-11). Therefore, one of the aims of our study was to observe if this gender difference was also apparent in older adults.

METHODS

Study Population

The Australian Diabetes, Obesity and Lifestyle (AusDiab) study was a population-based observational survey undertaken to estimate the prevalence of diabetes and its precursors in adults aged ≥ 25 years who were living in Australia (18). AusDiab was approved by the Ethics Committee of the Baker IDI Heart and Diabetes Institute (formerly the International Diabetes Institute). Baseline data was collected in 1999-2000 from 11,247 participants, representing 55% of those completing an initial household interview. Follow-up biomedical measurements were collected from 6,400 (59%) participants in 2004-2005. Further details regarding methods, sample size, eligibility, and representativeness from both data collections are available (18, 19). For the present study, we used data from the follow-up survey as concurrent measures of sedentary behavior were only collected at this time point, and limited the analysis to older adults (aged 60 years or older). Compared to those who only participated in the first survey, the older adults who participated in follow-up data collection (57% of men and 55% of women from baseline) were younger, had a lower TV viewing time, higher physical activity time, were more highly educated, with a higher proportion working, and with a lower proportion having the metabolic syndrome or smoking at baseline (all $p \leq 0.001$). We excluded those who reported more daily TV viewing time than overall sitting time (n=200), or who had missing data for variables of interest (n=378). Exclusion criteria were not mutually exclusive. Compared to those who were excluded, participants included in the analyses were younger, had lower TV viewing time, had higher physical activity time, overall sitting time, and self-rated health; with a lower proportion being male, having the metabolic syndrome, not completing high school, not smoking, and not employed ($p<0.05$). Of the 2,475 older adults who participated in follow-up data collection, 896 men and 1,062 women

were eligible for this study, or 79.1% of those older adults who participated in the follow-up data collection.

Variables Measured

Following an overnight fast (minimum 9 hours), participants attended a physical examination at a local test site for approximately 2.5 – 3 hours during which they provided written informed consent, provided a fasting blood sample, had physical measurements taken, and had demographic characteristics, medical history, and health behaviors assessed via interviewer-administered questionnaire. The AusDiab examination protocol, which has been described in detail elsewhere (18), closely followed the WHO recommended model for diabetes and other non-communicable disease field surveys (20). Specific details of the measures are summarised below.

The Metabolic Syndrome

According to the International Diabetes Federation (IDF) criteria (21), participants were considered to have the metabolic syndrome if they had three of the following components: abdominal obesity (waist circumference ≥ 94cm (men); ≥ 80cm (women)); raised triglyceride levels (serum triglycerides ≥ 1.7 mmol/L); reduced HDL-C levels (HDL-C < 1.0 mmol/L (men); < 1.3 mmol/L (women)); elevated blood pressure (blood pressure ≥ 130/85 mm Hg or treatment for hypertension); or glucose intolerance (fasting plasma glucose ≥ 5.6 mmol/L or previously diagnosed type 2 diabetes).

Physical measurements

Measurement of waist circumference and blood pressure were conducted by trained personnel. Waist circumference was measured twice, halfway between the lower border of the ribs and the iliac crest on a horizontal plane. If measurements varied by greater than 2cm,

a third was taken; the mean of the two closest measurements was calculated. Blood pressure measurement was performed in a seated position after participants had rested for at least five minutes, using a Dinamap semi-automatic oscillometric recorder. If the difference between the three readings was greater than 10mmHg, the mean of the two closest measurements was used.

Blood measurements

Blood was collected by venepuncture after an overnight fast. Blood specimens were centrifuged on-site and aliquoted for testing and storage. All analyses were conducted at a central laboratory. Fasting plasma glucose levels were determined by a spectrophotometric-hexokinase method (Roche Modular, Roche Diagnostics, Indianapolis, USA); fasting serum triglycerides and HDL-cholesterol were measured by enzymatic methods on an Olympus AU600 analyzer (Olympus Optical,Tokyo, Japan).

Demographics

Age, education (post-secondary education; or no formal education through to completing secondary education), and employment status (working – either in a full- or part-time job; or not working) were collected.

Lifestyle factors

Moderate- to vigorous-intensity physical activity (MVPA) was assessed using the Active Australia questionnaire (22), which is a reliable (test-retest reliability ICC=0.64; (23)) and valid (Spearman's ρ=0.50 assessed against accelerometer-assessed counts per day; (24)) instrument. MVPA was calculated as the sum of the time spent walking (if continuous and for 10 minutes or more) and in moderate-intensity physical activity, plus double the time spent in vigorous-intensity physical activity. The 'Active Australia' method accounts for the higher volume of energy expenditure per unit time that is associated with vigorous activities (25).

The activity level of participants was categorised according to current Australian physical activity guidelines for older adults (active [or meeting guidelines] = 150 mins/week or greater; inactive = less than 150 mins/week) (26). Other lifestyle factors assessed were smoking (current smoker; past smoker, or never smoked), alcohol consumption (heavy [more than 20g alcohol per day; based on Australian government recommendations for alcohol consumption (27)]), moderate, or none), self-rated health (0-100 with 100 being best imaginable health), and diet quality (0-100 with 100 being high diet quality). Diet quality was assessed with the Diet Quality Index-Revised (28), modified to reflect Australian dietary recommendations. An index is calculated from 10 separate nutritional elements (total fat, saturated fat, cholesterol, fruit, vegetables, grains, calcium, iron, dietary diversity and dietary moderation) and combined into a single score. Both diet quality and alcohol consumption were derived from data collected via the self-administered validated Anti-Cancer Council of Victoria food frequency questionnaire, which relates to the previous 12 months (29). Self-rated health was assessed using the EQ VAS (30) where participants rated their health on a vertical, visual analogue scale where the endpoints were labelled '*Best imaginable health state*' and '*Worst imaginable health state'*. Current estrogen / hormone replacement therapy (for women only) was categorised as yes/no.

TV viewing time

TV viewing time was measured using an instrument (test-retest reliability [ICC, 95% CI: 0.82, 0.75 to 0.87] and validity [assessed against a 3-day behavior log; Spearman's rank order correlation, r=0.3]) where participants reported the total time during the last week that they spent "*watching TV or videos while it was their main activity*" (31). TV viewing time was calculated as [(weekdays TV viewing + weekend days TV viewing) / 7] and reported in hours per day. Data for those who reported more than 16 hours of TV viewing time were truncated to 16 hours.

Overall sitting time

Overall sitting time was assessed with an instrument (test-retest reliability [Spearman's ρ=0.81; validity against accelerometer-derived sedentary time [*r*=0.34]) where participants reported the total time they spent "*sitting down while doing things like visiting friends, driving, reading, watching television, or working at a desk or computer*" on a typical weekday and typical weekend day in the last week (32). Overall sitting time was calculated as [((weekday sitting * 5) + (weekend day sitting * 2))/7] and reported in hours per day. Data for those who reported more than 18 hours of sitting per day were truncated to 18 hours. Note that TV viewing time and overall sitting time are not directly comparable as TV viewing time was assessed using total time in the last week, and overall sitting time was assessed using typical day in the last week.

Statistical Analyses

Differences in characteristics between men and women with and without the metabolic syndrome were assessed using Student's t-test (continuous variables) and Chi-square (categorical variables) analyses. The relationship for men and women of [1] TV viewing time with overall sitting time; [2] TV viewing time with MVPA; and [3] overall sitting time with MVPA, were assessed using bivariate correlations (Spearman's rho, ρ).

Forced entry logistic regression models were used to calculate the odds ratios (95% CI) for the presence of the metabolic syndrome and each of its components. Regression models included either TV viewing time or overall sitting time (as a categorical variable based on gender specific quartiles) and were adjusted for known and potential confounders: age, education, employment status, MVPA (hours/day), diet quality, smoking status, alcohol consumption, self-rated health and hormone replacement therapy / estrogen use (women

only). To calculate the increase in odds for each additional hour of sedentary behavior, TV viewing time and overall sitting time were entered into the models as continuous variables. Separate models were created for men and women. Interactions by gender (for the metabolic syndrome and each of its components) were assessed using interaction terms in models containing all participant data.

Additional models created for the entire eligible sample of older adults (adjusted as above with the inclusion of gender), were conducted using eight categories combining physical activity (active or inactive) and quartiles of TV viewing time or overall sitting time variable. The reference group was active and quartile 1 of TV viewing time / overall sitting time.

Findings from forced entry linear regression models (adjusted as above, and using components of the metabolic syndrome as continuous variables) were similar to those of our logistic regression models and are not reported.

Analyses were conducted using Stata Statistical Software Release 11.0 (StataCorp LP, College Station, TX, USA) with significance set at $p<0.05$ for main outcomes and $p<0.1$ for interactions.

RESULTS

The socio-demographic and behavioral characteristics of the sample are shown in Table 1. Overall 42% of participants (46% of men and 40% of women) had the metabolic syndrome. Participants with the metabolic syndrome had higher TV viewing time, and overall sitting time (women only), lower levels of physical activity, poorer self-rated health, with a lower proportion working than those without the syndrome. There was a significant positive correlation between TV viewing time and overall sitting time for men (ρ=0.39 [0.34 to 0.45], p<0.001) and for women (ρ=0.48 [0.43 to 0.52], p<0.001). In women there was a significant, yet very weak, negative correlation between MVPA and both measures of sedentary behavior (TV viewing time (ρ= -0.07 [-0.13 to -0.01], p= 0.017); overall sitting time (ρ= -0.06 [-0.12 to -0.002], p= 0.043)). These relationships were not significant in men (TV viewing time (ρ=0.03 [-0.04 to 0.09], p=0.439); overall sitting time (ρ= -0.03 [-0.09 to 0.04], p= 0.402)).

INSERT TABLE 1 ABOUT HERE

Associations of TV viewing time with the metabolic syndrome and its components

For each one-hour increase in TV viewing time, there was an increase in the odds of having the metabolic syndrome for men (1.10 [0.99, 1.22], p=0.075) and women (1.16 [1.05, 1.27], p=0.002).

Table 2 shows the prevalence and odds ratios of having the metabolic syndrome and each individual component of the syndrome by quartiles of TV viewing time. Compared to those in the bottom quartile, women in the top quartile had increased odds of having the

metabolic syndrome and reduced HDL-C levels and glucose intolerance, with significant linear trends observed for these and also for abdominal obesity. No significant associations were observed in men. There were no significant interactions of gender with TV viewing time.

INSERT TABLE 2 ABOUT HERE

Associations of overall sitting time with the metabolic syndrome and its components

For each one-hour increase in overall sitting time, there was an increase in the odds of having the metabolic syndrome for men (1.04 [0.99, 1.10], p=0.092) and women (1.05 [1.00, 1.10], p=0.070).

Table 3 shows the prevalence and odds ratios of having the metabolic syndrome and its components by quartile of overall sitting time. Compared to those in the bottom quartile, women in the top three quartiles of overall sitting time had increased odds of having the syndrome; however associations were only observed for men in the top quartile of overall sitting time. Compared to participants in the lowest quartile, men and women in the highest quartile of overall sitting time had increased odds of having raised triglyceride levels, while women had an increased risk of abdominal obesity, and men had an increased risk of reduced HDL-C levels. Significant linear trends were observed for the metabolic syndrome, abdominal obesity, and raised triglycerides in women. Significant interactions of gender with overall sitting time were observed for raised blood pressure (χ^2 [3 df]=7.30, p=0.063) such

that men had decreased odds and women had increased odds of having raised blood pressure; and abdominal obesity (χ^2 [3 df]=9.74, p=0.021) due to the increased odds in women in the second quartile of overall sitting time.

INSERT TABLE 3 ABOUT HERE

The exclusion of 191 men and 122 women with history of cardiovascular disease attenuated the significance and effect size for associations of TV viewing time with the metabolic syndrome for men (1.15 [0.72, 1.86], p=0.557) but not women (1.39 [0.96, 2.00], p=0.040). No attenuation was observed for overall sitting time, i.e. men (1.62 [1.00, 2.61], p=0.048) and women (1.50 [1.02, 2.21], p=0.040).

Physical activity, sedentary behavior and the metabolic syndrome

Panel A in the Figure shows the adjusted odds ratios for presence of the metabolic syndrome according to level of physical activity and TV viewing time. Compared to active participants in the lowest quartile of TV viewing time, inactive participants in the two highest quartiles of TV viewing time had increased odds of the metabolic syndrome, i.e. Q3: (1.77 [1.21, 2.59], p=0.003) and Q4: (2.04 [1.38, 3.03], p<0.001). The association for active participants in the highest quartile of TV viewing time approached significance (1.40 [0.97, 2.02], p=0.075).

INSERT FIGURE ABOUT HERE

Panel B in the Figure shows the adjusted odds ratios for presence of the metabolic syndrome according to level of physical activity and overall sitting time. Compared to active participants in the lowest quartile of overall sitting time, inactive participants in the top three quartiles of overall sitting time [Q4: (2.12 [1.47, 3.05], p<0.001); Q3 (1.49 [1.01, 2.20), p=0.047; Q2: (1.69 [1.19, 2.42], p=0.004)], and active participants in the top quartile of overall sitting time (1.43 [1.01, 2.02], p=0.042), had increased odds of having the metabolic syndrome.

DISCUSSION

This is one of the first studies to concurrently report associations of TV viewing time and overall sitting time with the presence of the metabolic syndrome and its components in a population-based sample of older men and women. High levels of overall sitting time (which provides summary information across all domains of sedentary behavior) were detrimentally associated with the metabolic syndrome and some components. All associations were independent of moderate- to vigorous-intensity physical activity and other lifestyle factors, highlighting the importance of considering time spent in sedentary behavior as a distinct health risk in older adults.

We found significant detrimental associations of TV viewing time with the metabolic syndrome in women but not men, consistent with previous studies conducted in general adult populations in Australia (9), the USA (10, 11), and Taiwan (8); and in a mid-age population in France (7). However, in our study, the relationships were in a similar direction and magnitude (hence the lack of significant gender interaction that was observed) which contrasts with previous studies where odds ratios were lower for men (ranging from 1.39 to 1.63) than for women (ranging from 1.54 to 3.30). A possible explanation for these gender differences is that TV viewing time is a broader marker of total leisure-time sedentary behavior in women but not in men (33). Higher levels of TV viewing time have been associated with higher energy intake (34) and increased snacking (35), although our results were adjusted for diet quality. Furthermore, the reliability and validity of the TV viewing time measure has not been separately assessed for men and women and there may also be differences in the way that men and women report their TV viewing time. Further investigation into the gender differences in associations of TV viewing time with the metabolic syndrome and its components is warranted.

An important and novel contribution of this study is the examination of overall sitting time with the metabolic syndrome and its components. These findings from Australia are similar to findings from older adults in the UK, where leisure-time sedentary behavior was detrimentally associated with continuous measures of waist circumference and HDL-C (36). In contrast to our findings for TV viewing time, in which associations were observed in women only, overall sitting time was associated with the metabolic syndrome and some components in both men and women. Our findings in older adults are consistent with those of a previous study in the general adult population that concurrently reported the associations of TV viewing time and overall sitting time with biomarkers of cardio-metabolic risk (13). Taken together, these findings suggest that future studies should include measures that capture sitting across all domains of sedentary behavior.

The mechanisms that underlie the contribution of prolonged sitting to the metabolic syndrome are yet to be fully elucidated. Studies by Hamilton and colleagues suggest that sedentary behavior has a unique physiological effect on the body, and that this is different than the effect of lack of exercise (37). In animal models, they observed a decreased level of lipoprotein lipase (LPL) in rats that were prevented from standing (38). Low levels of LPL are associated with increased levels of circulating fatty acids, due to blunted triglyceride uptake and reduced plasma HDL-C levels and are a biomarker for the severity of the metabolic syndrome (39).

It has been postulated that participation in sedentary behavior displaces time in physical activity. However, consistent with previous observations (33, 40), we found a low correlation between our measures of sedentary behavior and MVPA. An alternative behavioral mechanism for the observed associations may be that sedentary time displaces opportunities for time spent in light-intensity activity. Overall daily energy expenditure, which is a predictor of progression to the metabolic syndrome (41), is influenced by the

proportion of time distributed between activities of light and moderate intensity (42). Although time spent in light-intensity activity (which is difficult to capture by self-report) was not measured in this study, a previous study has shown that objectively-derived sedentary time and light-intensity physical activity are strongly inversely correlated (Pearson's r=-0.96) (40). Higher levels of light-intensity physical activity are beneficially associated with a lower waist circumference, and a reduced clustered metabolic risk score (40) and for older adults, increasing time in light-intensity physical activity has been shown to maintain bone health (43), improve functional ability and balance in mobility (44).

In this study, older adults who had higher levels of sitting time, regardless of whether they participated in recommended levels of physical activity, had increased odds of the metabolic syndrome, compared to those with low levels of overall sitting time. These findings support the suggestion (37, 45) that strategies to prevent chronic diseases in older adults (including the metabolic syndrome) should, in addition to increasing participation in physical activity, include messages on reducing prolonged sitting.

Strengths of this study include the use of two measures of sedentary behavior, i.e. TV viewing time and overall sitting time, and our adjustment for other lifestyle risk factors (physical activity, diet, smoking, and alcohol consumption) and confounding variables. Although this study had a large sample size our findings may not generalize as the sample was not weighted to the Australian population. One limitation of this study is the use of self-report measures of sedentary behavior, however both the measure of TV viewing time (31) and overall sitting time (32) have been shown to be reliable and valid for use at a population level.

While we cannot rule out reverse causality; for example, those who are unhealthy may sit more due to physical limitations, we took measures to limit this possibility, such as adjusting our models for self-rated health. Furthermore, when we limited our sample to those

without cardiovascular disease, the significant associations of overall sitting time with the metabolic syndrome remained, without any attenuation of effect size. A previous study with AusDiab participants found that increases in TV viewing time over the five year period from baseline to follow-up were associated with increases in waist circumference for both men and women, and increases in diastolic blood pressure and the clustered cardio-metabolic risk score in women only (46).

The recent studies linking TV viewing time with premature mortality (47, 48) are suggestive of a possible causal relationship between this behavior and health outcomes. Although cross-sectional research provides an important platform to establish whether associations exist between behaviors and health outcomes, intervention studies are now required to move this field of research beyond the cross-sectional stage to investigate causality. To date, two such intervention studies have been reported: in overweight adults aged 22-61 years (49); and in older adults aged 60 years or older (50). Further studies specifically measuring and intervening on sedentary, light-, and moderate- to vigorous-intensity physical activity are required.

In summary, we found that in older men and women, high levels of overall sitting time were significantly associated with an increased risk of the metabolic syndrome and some components, while high levels of TV viewing time were associated with an increased risk of the syndrome in women only. Promoting more time spent physically active (regardless of intensity), and less time spent sedentary is likely (at the very least) to have a beneficial impact on energy expenditure and may be a feasible and practical way for older adults to improve their health. Reducing sedentary behavior may be particularly important for those older adults whose health or physical functioning limits their participation in moderate-intensity physical activity.

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GRAPHICS

Figure – Adjusted odds ratios for presence of the metabolic syndrome (95%CI) according to level of physical activity and [A] TV viewing time; and [B] overall sitting time.

*p<0.05. Separate p for trends are reported for those who are active and inactive. Moderate- to vigorous-intensity (MVPA) category (active or inactive) interaction P values are presented in the box.

Models used in logistic regression analyses are adjusted for gender, age, education, alcohol consumption, smoking status, diet quality, and self-rated health. Cut-points for quartiles: 1.14, 2.00, 3.00 hours/day of TV viewing time, and 3.43, 4.99, 6.65 hours/day of overall sitting time.

Table 1 – Selected characteristics of older men and women according to the presence of the metabolic syndrome

Characteristic	**Men (n=896)**			**Women (n=1,062)**		
	No Met S (n=487)	**Met S (n=409)**	**p**	**No Met S (N=642)**	**Met S (n=460)**	**p**
Age (years)	69.7 (69.0, 70.4)	69.4 (68.7, 70.1)	0.509	68.9 (68.4, 69.4)	69.3 (68.7, 70.0)	0.323
Currently working	32.9	26.2	0.029	21.8	16.4	0.031
Completed High School (%)	59.3	54.5	0.146	48.6	41.7	0.027
Smoker (%)	59.1	62.4	0.588	32.1	34.1	0.756
High Alcohol Consumption (%)	6.8	6.4	0.968	1.6	0.7	0.408
Diet Quality	64.4 (63.3, 65.4)	63.9 (62.8, 65.1)	0.606	70.0 (69.2, 70.9)	69.4 (68.3, 70.4)	0.335
Self-rated health	82.7 (81.4, 83.9)	79.4 (77.9, 80.9)	<0.001	81.4 (80.2, 82.5)	78.1 (76.6, 79.6)	<0.001
MVPA time (hours/day)	0.82 (0.75, 0.90)	0.67 (0.60, 0.74)	0.005	0.69 (0.63, 0.75)	0.53 (0.48, 0.59)	<0.001
Meet physical activity guidelines (%)[§]	63.5	58.2	0.108	58.7	47.6	<0.001

Characteristic	Men (n=896)			Women (n=1,062)		
	No Met S (n=487)	Met S (n=409)	p	No Met S (N=642)	Met S (n=460)	p
Absence of chronic conditions (%)	37.2	17.6	<0.001	34.6	15.2	<0.001
TV viewing time (hours/day)	2.06 (1.96, 2.17)	2.28 (2.13, 2.42)	0.021	2.04 (1.94, 2.14)	2.42 (2.27, 2.58)	<0.001
Sitting Time (hours/day)	5.27 (5.03, 5.50)	5.61 (5.33, 5.89)	0.060	5.11 (4.91, 5.31)	5.44 (5.20, 5.68)	0.042

Data are presented as means (95% CI) unless stated.

MVPA is moderate- to vigorous-intensity physical activity; diet quality and self-rated health scores range from 0 to 100, with 100 representing better diet quality/health; smoker is current or past smoker; high alcohol consumption is > 20g alcohol/day (based on Australian government recommendations).

[§]Based on the recommended Australian public health guidelines for older adults (≥150 mins/wk) (26)

Table 2 – Prevalence and likelihood of having the metabolic syndrome or an individual component, by quartile of TV viewing time in men and women

		Men		Women	
	Quartile	Prevalence (%)	OR (95% CI)	Prevalence (%)	OR (95% CI)
Metabolic Syndrome	1	41.8	1.00	34.7	1.00
	2	42.4	1.15 (0.81, 1.65)	33.7	0.95 (0.64, 1.40)
	3	45.1	1.11 (0.76, 1.61)	40.8	1.21 (0.85, 1.72)
	4	52.8	1.42 (0.93, 2.15)	46.7	1.42 (1.01, 2.01)*
P for trend			0.154		0.025
Abdominal obesity	1	67.6	1.00	73.7	1.00
	2	70.3	1.14 (0.78, 1.68)	66.3	0.71 (0.48, 1.07)
	3	71.2	1.19 (0.79, 1.78)	75.9	1.10 (0.74, 1.63)
	4	77.6	1.59 (0.99, 2.57)	81.8	1.48 (0.99, 2.22)
P for trend			0.070		0.026
Raised triglycerides	1	28.3	1.00	29.3	1.00
	2	27.5	1.00 (0.67, 1.49)	24.1	0.76 (0.50, 1.16)
	3	28.8	1.00 (0.66, 1.51)	30.6	1.00 (0.69, 1.45)
	4	38.5	1.55 (0.99, 2.42)	37.4	1.35 (0.95, 1.92)
P for trend			0.094		0.059
Reduced HDL-C	1	21.3	1.00	15.5	1.00
	2	21.2	1.07 (0.69, 1.66)	12.3	0.82 (0.47, 1.42)

		Men		Women	
	Quartile	Prevalence (%)	OR (95% CI)	Prevalence (%)	OR (95% CI)
	3	19.4	0.88 (0.55, 1.40)	21.9	1.60 (1.03, 2.50)*
	4	20.5	0.96 (0.57, 1.60)	23.0	1.64 (1.06, 2.54)*
	P for trend		0.646		0.005
Raised blood pressure	1	66.4	1.00	58.3	1.00
	2	73.6	1.32 (0.89, 1.96)	63.6	1.14 (0.76, 1.71)
	3	65.3	0.93 (0.62, 1.38)	69.4	1.31 (0.90, 1.91)
	4	72.1	1.07 (0.67, 1.69)	69.0	1.15 (0.80, 1.66)
	P for trend		0.777		0.341
Glucose intolerance	1	40.6	1.00	26.3	1.00
	2	42.4	1.08 (0.76, 1.55)	24.6	0.90 (0.59, 1.38)
	3	46.9	1.28 (0.88, 1.86)	31.3	1.29 (0.88, 1.87)
	4	46.6	1.27 (0.84, 1.93)	35.1	1.45 (1.01, 2.09)*
	P for trend		0.154		0.020

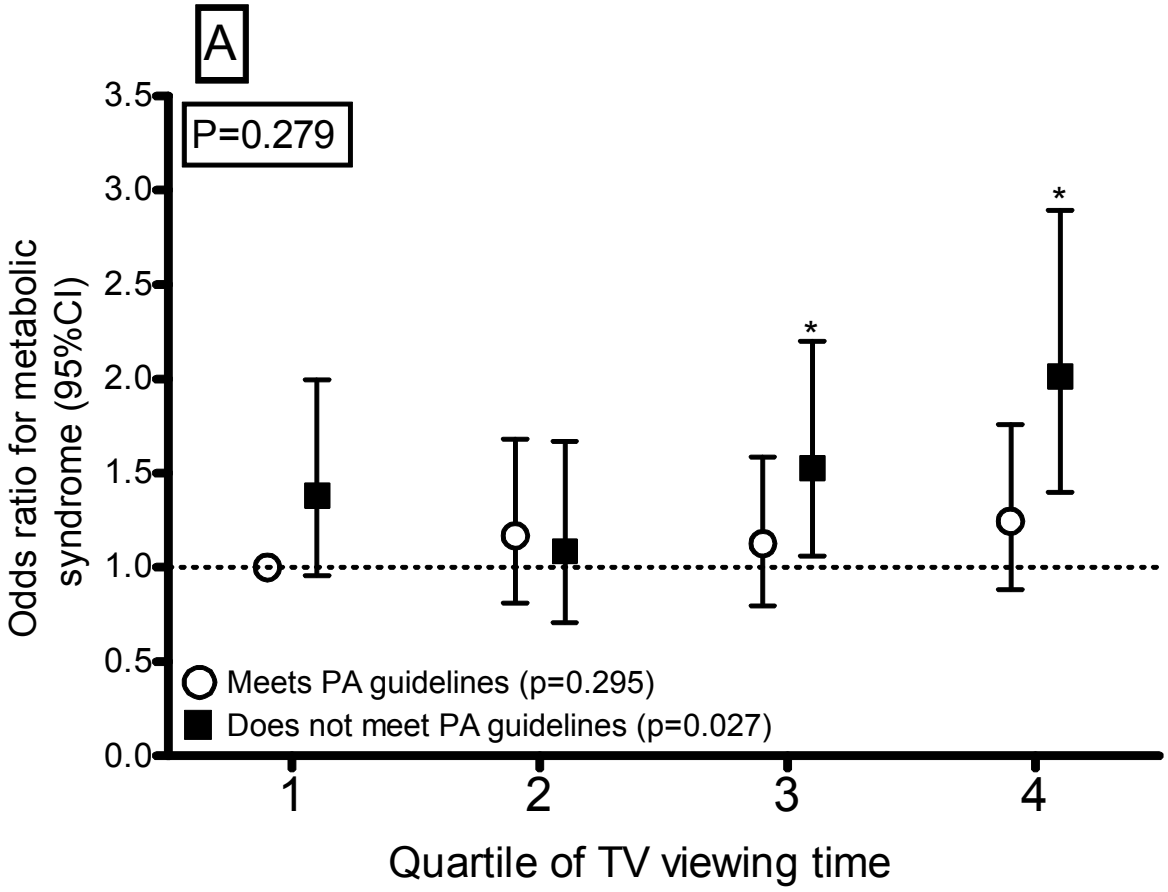
*p<0.05; †p<0.01; ‡p<0.001. Models used in logistic regression analysis are adjusted for age, education, alcohol consumption, smoking status, diet quality, self-rated health, and physical activity. Cut-points for quartiles of TV viewing time: 1.29, 2.00, 3.00 hours/day for men, and 1.14, 2.00, 3.00 hours/day for women.

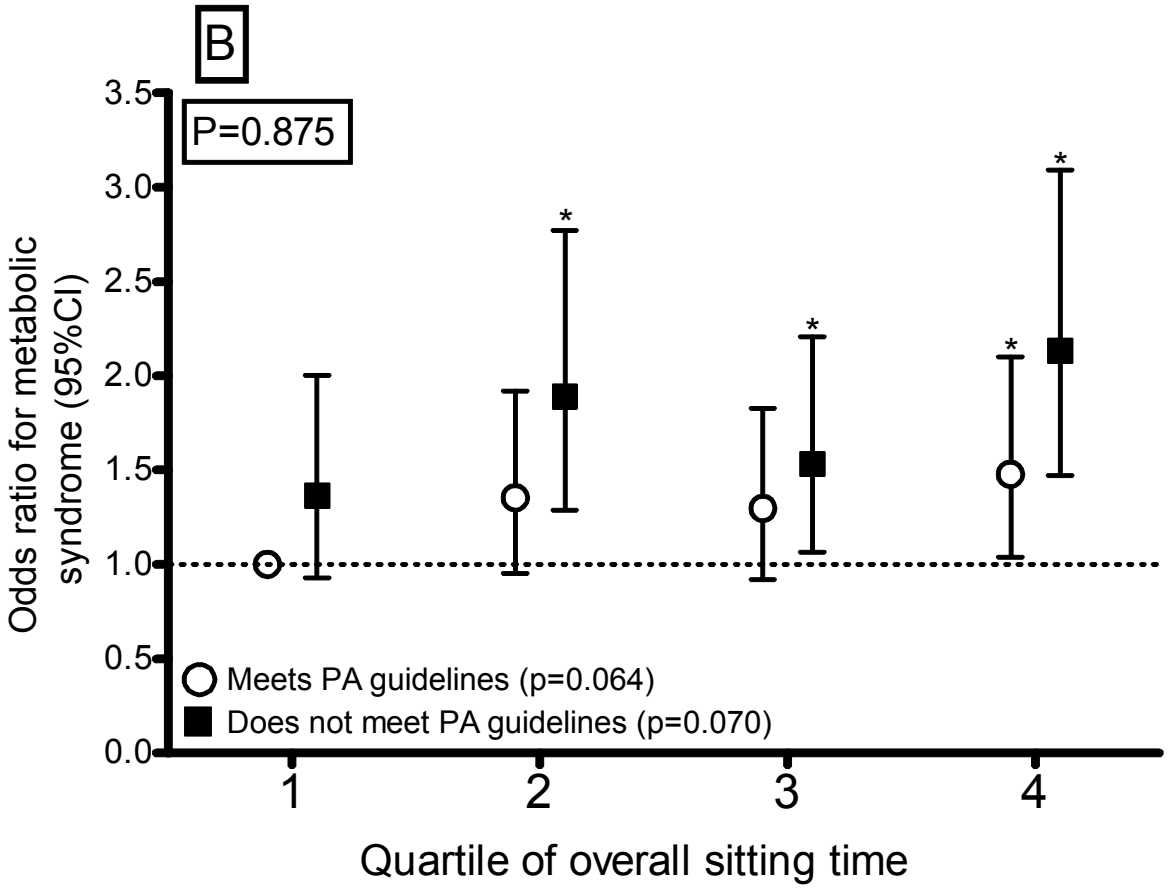
Table 3 – Prevalence and likelihood of having the metabolic syndrome or an individual component, by quartile of overall sitting time in men and women.

		Men		Women	
	Quartile	Prevalence (%)	OR (95% CI)	Prevalence (%)	OR (95% CI)
Metabolic Syndrome	1	41.3	1.00	32.0	1.00
	2	47.4	1.21 (0.81, 1.80)	41.3	1.53 (1.06, 2.20)*
	3	42.5	0.98 (0.67, 1.44)	42.2	1.51 (1.05, 2.16)*
	4	53.4	1.57 (1.02, 2.41)*	42.8	1.56 (1.09, 2.24)*
	P for trend		0.156		0.024
Abdominal obesity	1	68.5	1.00	67.7	1.00
	2	69.7	1.01 (0.66, 1.55)	80.7	2.11 (1.40, 3.18)‡
	3	70.5	1.04 (0.69, 1.55)	74.1	1.35 (0.92, 1.97)
	4	76.7	1.52 (0.94, 2.45)	79.2	1.81 (1.21, 2.70)†
	P for trend		0.124		0.025
Raised triglycerides	1	25.0	1.00	25.3	1.00
	2	32.0	1.39 (0.89, 2.16)	30.1	1.29 (0.88, 1.91)
	3	28.3	1.16 (0.75, 1.77)	32.6	1.41 (0.97, 2.07)
	4	35.8	1.61 (1.01, 2.58)*	36.4	1.66 (1.14, 2.41)†
	P for trend		0.133		0.008
Reduced HDL-C	1	16.3	1.00	16.7	1.00
	2	20.6	1.32 (0.79, 2.21)	17.4	1.05 (0.66, 1.68)

		Men		Women	
	Quartile	Prevalence (%)	OR (95% CI)	Prevalence (%)	OR (95% CI)
	3	19.8	1.21 (0.74, 1.98)	20.0	1.23 (0.79, 1.93)
	4	26.7	1.78 (1.05, 3.02)*	20.8	1.27 (0.81, 1.99)
	P for trend		0.066		0.225
Raised blood pressure	1	70.7	1.00	59.1	1.00
	2	72.4	0.98 (0.63, 1.53)	66.8	1.41 (0.97, 2.06)
	3	67.5	0.76 (0.50, 1.15)	69.3	1.50 (1.03, 2.19)*
	4	67.1	0.87 (0.55, 1.39)	65.5	1.29 (0.88, 1.87)
	P for trend		0.295		0.164
Glucose intolerance	1	47.8	1.00	28.3	1.00
	2	41.2	0.75 (0.50, 1.11)	28.6	1.00 (0.68, 1.46)
	3	41.6	0.77 (0.53, 1.11)	30.7	1.09 (0.75, 1.59)
	4	46.59	0.92 (0.60, 1.40)	31.8	1.17 (0.81, 1.71)
	P for trend		0.676		0.347

*p<0.05; †p<0.01; ‡p<0.001. Models used in logistic regression analysis are adjusted for age, education, alcohol consumption, smoking status, diet quality, self-rated health, and physical activity. Cut-points for quartiles of overall sitting time: 3.25, 4.75, 7.00 hours/day for men, and 3.43, 4.99, 6.50 hours/day for women.


A
P=0.279
Odds ratio for metabolic syndrome (95%CI)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
*
*
*
Meets PA guidelines (p=0.295)
Does not meet PA guidelines (p=0.027)
1
2
3
4
Quartile of TV viewing time


B
P=0.875
Odds ratio for metabolic syndrome (95%CI)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
*
*
*
*
Meets PA guidelines (p=0.064)
Does not meet PA guidelines (p=0.070)
1
2
3
4
Quartile of overall sitting time