Television Viewing Time and Sitting Time: are they similarly associated with biomarkers of cardio-metabolic risk? The AusDiab Study.

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Background

- Epidemiological evidence indicates that sedentary behaviour (prolonged sitting) is an important contributor in poor metabolic health outcomes (1-3), independent of leisure-time physical activity (1;3-5).
- Most studies reporting on the metabolic consequences from sedentary behaviour have focussed on associations with leisure-time specific sitting, particularly television (TV) viewing time (3-6).
- Whilst prolonged sitting in contexts other than the domestic setting remains largely unknown, occupational sitting time (a non discretionary sedentary behaviour) has been linked to weight gain and central adiposity in men (7).
- Whether it is more appropriate to assess population-based, cardio-metabolic risk on the accumulation of leisure and non-discretionary sedentary behaviour, as opposed to a single domain (TV viewing) is yet to be determined.
- In a large, population-based sample of Australian Adults, we compared associations of TV viewing and sitting time with biomarkers for cardio-metabolic health to ascertain which measure is most suitable for assessing risk in both men and women.

Methods

- AusDiab is a national, population-based survey of 11,247 Australians aged ≥ 25 years, conducted in 1999/2000, that were followed up in 2004/2005 (AusDiab 2). Of the 8,798 eligible participants in AusDiab 2, 6,400 (59.3%) attended the testing site. The present analysis includes the 4,789 adults who attended AusDiab2 and who were free from diagnosed diabetes and had no history of CVD.
- Information was collected by physical examination and questionnaire at the local survey site. A fasting blood sample was taken and an OGTT was performed.
- Self-reported TV viewing time and sitting time were calculated by asking participants to report separately for a typical weekday and weekend day on the following questions.

> ***Q:*** *Please estimate the total time during the last week that you spent sitting for watching TV or DVD's or playing games on the TV. This was when it was the main activity that you were doing; on work days and on non-work days.*
>
> ***Q:*** *How many hours and/or minutes did you spend sitting down while doing things like visiting friends, driving, reading, watching TV or working at a desk or a computer; on a typical work day and a typical non-work day in the last week?*

- Leisure-time physical activity was calculated as the sum of the total time spent walking and performing moderate activity (excluding gardening), plus double the time spent in vigorous activity (to reflect its greater intensity) in the previous week.
- Linear regression models examined associations between sitting and TV viewing time with individual cardio-metabolic risk variables. Model A adjusted for several potential confounders (age, employment status, education, cigarette smoking, parental history of diabetes, alcohol, energy and alcohol intake and diet quality). Model B additionally adjusted for waist circumference. To account for skewness, FPG, 2-hr PG, insulin, triglycerides, and HDL-cholesterol were logarithmically transformed for the analysis.
- Standardised beta regression coefficients (β) were calculated (using standardised z-scores) to compare magnitude of associations. Unstandardised regression coefficients were calculated to enable the clinical interpretation of one hour of sitting or TV viewing on metabolic risk.

Results

- TV viewing time and sitting time were correlated in both men (r=0.26, P<0.001) and women (r=0.36, P<0.001).
- Sitting time had the strongest deleterious association with serum insulin in women and HDL-cholesterol in men; while TV viewing time had the strongest association with waist circumference and triglycerides in women (0.07) and FPG in men (0.07) (Table 2).
- In women, except for FBG, sitting time and TV viewing time were similarly associated with metabolic biomarkers (Table 3).
- In men, sitting time was deleteriously associated with a greater number of metabolic biomarkers than TV viewing time. All metabolic biomarkers, with the exception diastolic blood pressure and FBG, were deleteriously associated with sitting time (Table 3).
- In general, sitting time was associated with the same biomarkers in men and women. In comparison, only waist circumference, FPG , 2hr PG, insulin and diastolic blood pressure were associated with TV viewing in both men and men (Table 3).
- Further adjustment for waist circumference attenuated several deleterious associations observed in women but did not alter the significant associations in men (Table 3).

Table 1. Selected characteristics of study participants according to sex

	Women (n=2,712)	Men (n=2,077)	p-value
Age, years	54.8 (54.3, 55.2)	55.0 (54.4, 55.5)	0.64
Completed university/further education, %	64.7 (62.9, 66.5)	69.3 (67.3, 71.2)	<0.001
Current smoker, %	7.1 (6.1, 8.0)	10.5 (9.2, 11.8)	<0.001
Employed, %	59.8 (58.0, 61.7)	71.8 (69.8, 73.7)	<0.001
Parental history of diabetes, %	20.6 (19.0, 22.1)	17.6 (16.0, 19.3)	0.01
Total energy intake (KJ/day)	6927 (6847,7007)	9215 (9098, 9332)	<0.001
Total alcohol (ml/day)	9.27 (8.79, 9.75)	20.2 (19.3, 21.1)	<0.001
Diet quality index (DQI-R, 1-100)	66.6 (66.1, 67.1)	61.6 (61.0, 62.1)	<0.001
Leisure physical activity time (hrs/day)	0.66 (0.64, 0.69)	0.76 (0.73, 0.80)	<0.001
Sitting time (hrs/day)	5.25 (5.15, 5.34)	5.74 (5.63, 5.85)	<0.001
Television viewing time (hrs/day)	1.72 (1.67, 1.76)	1.86 (1.81, 1.92)	<0.001
Waist circumference (cm)	86.5 (86.0, 87.0)	98.2 (97.7, 98.7)	<0.001
Fasting plasma glucose (mmol/L)	5.19 (5.17, 5.21)	5.44 (5.41, 5.46)	<0.001
2-hr plasma glucose (mmol/L)	5.56 (5.50, 5.62)	5.55 (5.47, 5.62)	0.31
Fasting serum insulin (pmol/L)	47.1 (46.0, 48.1)	52.0 (50.6, 53.4)	<0.001
Fasting serum triglycerides (mmol/L)	1.14 (1.12, 1.16)	1.39 (1.36, 1.42)	<0.001
Fasting HDL-cholesterol (mmol/L)	1.54 (1.53, 1.56)	1.23 (1.22, 1.25)	<0.001
Systolic blood pressure (mmHg)	119.5 (118.7,120.2)	126.8 (126.0,127.5)	<0.001
Diastolic blood pressure (mmHg)	65.6 (65.2, 66.0)	72.9 (72.5, 73.3)	<0.001

Notes: Data are means (95% CI) or %. Geometric means are reported for FPG, 2-hr PG, insulin, triglycerides and HDL-cholesterol: log10 transformations of these variables used to test for sex-differences.

Table 2. Standardised regression coefficients (β) of sitting time (hrs/day) and TV viewing time (hrs/day) with biomarkers of metabolic risk according to sex

	Women	Men
Waist Circumference (cm)		
TV viewing time	0.07 ± 0.29 *** (0.10)	0.03 ± 0.28 (0.08)
Sitting time	0.07 ± 0.27 *** (0.10)	0.06 ± 0.26 ** (0.08)
Fasting plasma glucose (mmol/L)		
TV viewing time	0.04 ± 0.002 (0.06)	0.07 ± 0.003** (0.05)
Sitting time	0.01 ± 0.002 (0.06)	-0.02 ± 0.003 (0.05)
Fasting serum insulin (pmol/L)		
TV viewing time	0.06 ± 0.01 ** (0.13)	0.04 ± 0.02 (0.11)
Sitting time	0.09 ± 0.01 *** (0.13)	0.08 ± 0.01 *** (0.11)
2-hr plasma glucose (mmol/L)		
TV viewing time	0.02 ± 0.01 (0.09)	0.05 ± 0.01 * (0.11)
Sitting time	0.06 ± 0.01 ** (0.09)	0.04 ± 0.01(0.11)
Fasting serum triglycerides (mmol/L)		
TV viewing time	0.07 ± 0.01 *** (0.13)	0.01 ± 0.01 (0.05)
Sitting time	0.07 ± 0.01 *** (0.13)	0.08 ± 0.01 *** (0.05)
Fasting HDL-cholesterol (mmol/L)		
TV viewing time	-0.03 ± 0.01 (0.12)	0.005 ± 0.01 (0.08)
Sitting time	-0.05 ± 0.01 * (0.12)	-0.09 ± 0.01 *** (0.08)
Systolic blood pressure (mmHg)		
TV viewing time	0.04 ± 0.41 * (0.26)	0.02 ± 0.42 (0.14)
Sitting time	0.03 ± 0.38 (0.26)	-0.05 ± 0.38 * (0.14)
Diastolic blood pressure (mmHg)		
TV viewing time	0.05 ± 0.22 * (0.04)	0.04 ± 0.24 (0.05)
Sitting time	0.04 ± 0.21 (0.04)	0.02 ± 0.22 (0.05)

Notes: Multivariate linear regression using standardised values (z-scores). Data are β coefficient ± SE (adjusted r- squared) *p<0.05; **p<0.01; ***p<0.001. TV viewing time and sitting time represented as hours per day. Adjusted for age, education, parental history of diabetes, employment status, cigarette smoking, total energy and alcohol intake, diet quality, leisure physical activity time, anti-hypertensive and lipid-lowering medication.

Table 3. Unstandardised regression coefficients of sitting time (hrs/day) and TV viewing time (hrs/day) with biomarkers of metabolic risk according to sex.

	TV Viewing Time		Sitting Time	
	Women	Men	Women	Men
Waist Circumference (cm)				
Model A	1.16 (0.75, 1.57) ***	0.57 (0.16, 0.98) **	0.52 (0.33, 0.71) ***	0.33 (0.14, 0.51) ***
Model B	-	-	-	-
Fasting plasma glucose (mmol/L)				
Model A	0.02 (0.002, 0.04)*	0.03 (0.01, 0.06) **	0.01 (-0.003, 0.01)	-0.0002 (-0.01, 0.01)
Model B	0.002 (-0.01, 0.02)	0.03 (0.002, 0.05) *	-0.002 (-0.01, 0.01)	-0.01 (-0.02, 0.01)
Fasting serum insulin (pmol/L)				
Model A	4.03 (2.59, 5.46) ***	2.93 (0.97, 4.90) ***	2.01 (1.35, 2.67) ***	1.57 (0.69, 2.45) ***
Model B	1.72 (0.53, 2.91) **	1.48 (-0.19, 3.16) *	0.98 (0.43, 1.53) ***	0.73 (-0.02, 1.48) ***
2-hr plasma glucose (mmol/L)				
Model A	0.07 (0.01, 0.12) **	0.13 (0.05, 0.20) **	0.05 (0.02, 0.07) ***	0.04 (0.01, 0.08) **
Model B	0.02 (-0.04, 0.07)	0.11 (0.04, 0.18) ***	0.02 (-0.0003, 0.05) *	0.03 (-0.002, 0.06) *
Fasting serum triglycerides (mmol/L) †				
Model A	0.05 (0.03, 0.07) ***	0.03 (-0.01, 0.07)	0.02 (0.01, 0.03) ***	0.03 (0.01, 0.05) ***
Model B	0.03 (0.01, 0.05) ***	0.12 (-0.02, 0.06)	0.01 (0.005, 0.02) ***	0.02 (0.01, 0.04) **
Fasting HDL-cholesterol (mmol/L) †				
Model A	-0.02 (-0.03, -0.01) *	-0.01 (-0.02, 0.01)	-0.01 (-0.01, -0.003) **	-0.01 (-0.02, -0.005) ***
Model B	-0.01 (-0.02, 0.01)	-0.001 (-0.01, 0.01)	-0.003 (-0.01, 0.002)	-0.01 (-0.01, -0.002) **
Systolic blood pressure (mmHg) ‡				
Model A	0.86 (0.30, 1.43) **	0.11 (-0.49, 0.72)	0.33 (0.07, 0.59) *	-0.29 (-0.56, -0.02) *
Model B	0.50 (-0.05, 1.05)	-0.04 (-0.63, 0.55)	0.16 (-0.10, 0.42)	-0.38 (-0.65, -0.12) **
Diastolic blood pressure (mmHg) ‡				
Model A	0.52 (0.21, 0.82) **	0.34 (0.002, 0.68) *	0.22 (0.08, 0.36) **	0.12 (-0.03, 0.28)
Model B	0.36 (0.06, 0.67) *	0.25 (-0.08, 0.58)	0.15 (0.01, 0.29) *	0.07 (-0.08, 0.22)

Notes: Multivariate linear regression. Data are mean (95% CI) *p<0.05; **p<0.01; ***p<0.001.
Model A: Adjusted for age, education, parental history of diabetes, employment status, cigarette smoking, total energy and alcohol intake, diet quality & leisure physical activity time. Model B: adjusted for all covariates plus waist circumference. Models additionally adjusted for lipid-lowering (†) and anti-hypertensive (‡) medication.

Summary and Conclusions

- In this large, cross sectional study of Australian adults, sitting time was shown to have more consistent deleterious associations with cardio-metabolic biomarkers than TV viewing time in both men and women.
- In men, and to a lesser extent in women, the detrimental associations between sitting time with cardio-metabolic risk factors were independent of waist circumference.
- The findings of similar associations between TV viewing and sitting time with biomarkers of cardio-metabolic risk in women is consistent with previous reports that TV viewing time is a proxy marker of women's broader pattern of sedentary behaviour (8).
- Sitting time accumulated across the entire day may be a more useful measure for assessing cardio-metabolic risk than a single sedentary behaviour ie. TV viewing in a mixed population.

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