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ABSTRACT

***Objective*:** Television (TV) viewing, a common leisure-time sedentary behaviour, is associated adversely with cardio-metabolic health, fatigue, depression and mental health. However, associations of TV viewing time with health-related quality of life attributes are less well understood. We examined associations of TV viewing time with physical wellbeing, mental wellbeing and vitality in a large population-based sample of Australian adults.

***Method*:** The study sample comprised 4,483 men and 5,424 women (mean age 51±14 years) from the Australian Diabetes, Obesity and Lifestyle study (1999-2000). Multiple linear regressions examined associations of TV viewing time (hr/day) with the SF-36v1 physical and mental health component summary scores and the vitality sub-score, adjusting for leisure-time physical activity and waist circumference.

***Results*:** Each 1-hr/day increment in TV viewing time was associated with lower physical (-0.56 ([95% CI: -0.77, -0.34]) and mental (-0.41 [-0.70, -0.12]) component summary scores and vitality (-0.51 [-0.81, -0.21]). Associations remained significant after adjustment for leisure-time physical activity and waist circumference. There was a gender interaction for the association of TV viewing time with vitality (significant in men only).

***Conclusions*:** TV viewing time is associated adversely with physical wellbeing, mental wellbeing and vitality. Further studies are required to better understand potential causal relationships and variations by gender.

HIGHLIGHTS

- TV time was associated adversely with physical & mental wellbeing and vitality.
- A relationship with vitality was found for men, but not for women.
- With high TV time, physical activity only partially protective for mental wellbeing.
- Further (particularly prospective) studies are needed on gender differences.

Keywords: television viewing; sedentary behaviour; quality of life; wellbeing; vitality; mental health; gender; physical activity.

INTRODUCTION

As life expectancy continues to increase in many countries, healthy ageing that sustains quality of life and wellbeing is an increasingly relevant public health focus [1]. There are well-documented benefits of regular moderate-to-vigorous physical activity for mental and physical health and quality of life. However, limited uptake and adherence to physical activity guidelines, for example, those from the Australian Department of Health [2], continue to be challenging realities at the population level [3].

Sedentary behaviours – defined by low energy expenditure (ranging from 1.0-1.5 metabolic equivalents) in a sitting or reclining position [4, 5] – have emerged as an additional element with concerns about physical activity and health. Television (TV) viewing time, a common leisure-time sedentary behaviour, has been associated with major chronic diseases and adverse cardio-metabolic health outcomes [6, 7], decreased life expectancy [8], and all-cause and cardiovascular mortality [9-11].

Despite increasing evidence on the detrimental health consequences of high volumes of TV viewing time, little is known about the relationships of TV viewing time with health-related quality of life. Health-related quality of life is conceptualised as perceptions of functioning and its impact [12], aligning with World Health Organization definitions that include physical, mental, and social wellbeing [13]. In this perspective, measures of physical and mental wellbeing and vitality can be seen to provide key health-related evidence that is complementary to morbidity and mortality outcomes [14-16]. Cross-sectional and prospective relationships of TV viewing time and total sitting time with feelings of energy/fatigue [14], depression [17-19] and poorer mental health [20-24] have been identified. A number of mostly cross-sectional studies have reported consistent but small associations between screen time and poorer mental health in young people [25], with one longitudinal study (7 years follow up) showing higher TV viewing was associated with increased odds of depressive symptoms, particularly in young men [26]. Nonetheless, limited studies have addressed the impact of TV viewing time on physical wellbeing, mental wellbeing and vitality in adults, particularly with adjustment for leisure-time physical activity.

In a large population-based sample of Australian adults, we examined associations of TV viewing time with physical wellbeing, mental wellbeing and vitality. Given the evidence on positive relationships of physical activity with physical and mental wellbeing and vitality [27, 28], we controlled for leisure-time physical activity in our models and examined the joint

associations of TV viewing time with leisure-time physical activity. Furthermore, as several studies have identified differing relationships of TV viewing time with health-related attributes for women and men, including stronger relationships with cardio metabolic biomarkers for women [6, 29-31], we therefore examined potential variations in associations by gender.

MATERIALS AND METHODS

Participants and procedures

The Australian Diabetes, Obesity and Lifestyle Study (*AusDiab*) was conducted during 1999–2000 using data from a large population-based sample of adults as previously described [32]. From the cohort of 11,247 who participated in the baseline examination at a local survey testing site, we excluded participants who were pregnant (n=60), had missing SF-36 data (n=166), or had missing exposure and covariate data (n=1,114). This left a final sample of 9,907 (4,483 men and 5,424 women).

Television viewing time

Total time spent watching television or videos in the past week was assessed separately for weekdays and weekends, based on response to the interviewer administered question: "Please estimate the total time during the last week that you spent sitting for watching TV or DVDs or playing games on the TV. This is when it was the main activity that you were doing." TV viewing time was then calculated (h/day) using the formula [(workdays TV viewing time + non-workdays TV viewing time)/7] [6]. This measure has been shown to provide a reliable and valid estimate of television viewing time among adults [33].

Physical and mental wellbeing and vitality

Physical wellbeing, mental wellbeing and vitality were assessed using the SF-36 (v1) health survey; a valid and reliable instrument that is widely used among medically ill and healthy populations [34, 35]. The SF-36 yields eight domains assessing physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role emotional and mental health [36, 37] and uses norm-based weights to account for cultural differences in the way the health and health-related quality of life are perceived by different populations [36, 38]. The domain scores are standardised to a mean of 50 and standard deviation of 10. Domain scores can be aggregated to provide a physical component summary score (including physical

functioning, role physical, bodily pain and general health perceptions) and mental component summary score (including vitality, social functioning, mental health and role emotional) [36].

Potential confounding variables

Demographic attributes (gender, age, and education, employment, marital and menopausal status), behavioural characteristics (leisure-time physical activity, smoking status, alcohol intake and diet quality) and co-morbidities (known diabetes and history of cardiovascular disease – including stroke, angina or heart attack) of participants were assessed using interviewer-administered questionnaires. Women were classified as postmenopausal if they had: experienced menopause (defined as absence of menses > previous 6 months); were currently experiencing menopause; were unsure of menopausal status and >55 years; had undergone hysterectomy, or were aged >60 years [39]. Leisure-time physical activity including walking for recreation or transport, other moderate-intensity activity and vigorous-intensity activity, and was assessed for the previous week using the Active Australia Survey Questionnaire [40]. Physical activity categories were created to reflect current public health recommendations: those meeting the current public health physical activity guidelines (≥150 min/wk) and those not meeting guidelines (<150 min/wk). Habitual diet quality was derived from a self-administered, validated food frequency questionnaire using a revised scale of 1-100, with 100 representing high diet quality [41]. Mean waist circumference was calculated from two measurements taken halfway between the border of the lower ribs and the iliac crest, measured to the nearest 0.5cm

Statistical analyses

Statistical analyses were conducted using Stata-12 for Windows (StataCorp LP). All analyses were weighted to represent the non-institutionalised Australian population, to account for non-response and non-coverage in the sampling and produce nationally representative estimates. Seven of the SF-36 domain scores (all except vitality) exhibited large ceiling effects beyond commonly used transformation techniques. On this basis, the decision to only statistically analyse the normally distributed physical and mental component summary scores and the vitality sub-score was in line with our rationale and avoided violating regression normality assumptions.

All potential covariates were identified a priori and a backward step-wise elimination (P<0.20 for variable retention) process was employed, after which smoking status and alcohol consumption (g/day) were removed from the model. Multiple linear regression

models were used to examine the associations of TV viewing time with the physical and mental component summary scores and with the vitality sub-score, adjusting for potential confounding variables. Model A adjusted for age. Model B adjusted for age, gender, education (completed university or higher education), diet quality, employment status (employed part-time/full time), marital status (married/de facto, widowed, divorced/separated, never married), diabetes status, cardiovascular disease history. Model C adjusted for the covariates included at Model B, plus total leisure-time physical activity (min/week). Model D included additional adjustment for waist circumference.

Interaction terms examined variations of the associations with physical and mental wellbeing and vitality by gender in the fully adjusted models (Model D). Gender-specific tertiles of TV viewing time (cut points for TV viewing time in men: 1.30, and 2.31 h/day; and women: 1.07, and 2.01 h/day) were derived to further describe the associations of TV viewing time with physical and mental wellbeing and vitality across the range of TV viewing time. Leisure-time physical activity-specific tertiles of TV viewing time (cut points for TV time for those categorised as insufficiently active: 1.16, and 2.25 h/day; and sufficiently active: 1.18, and 2.21 h/day) were also derived to examine the associations of combinations of TV viewing time and leisure-time physical activity with physical and mental wellbeing and vitality. Joint-associations were examined using linear regression in the fully adjusted models (Model D). Statistical significance was set at $P<0.05$ for the main effects and for interactions.

RESULTS

Characteristics of study participants

As shown in Table 1, a higher proportion of women had completed higher education, but more men were married and employed in full/part-time work. Women watched less TV but were also less physically active than men, while men had higher physical and mental wellbeing and vitality scores overall. Co-morbidities did not differ significantly between men and women. Compared with those in the analytic sample, participants who were excluded due to missing data reported slightly lower levels of leisure time physical activity (274.6±331.1 vs. 262.8±331.7 min/wk, $P=0.23$) and slightly higher levels of TV viewing time (1.8±1.4 vs. 1.9±1.5 hr/day, $P=0.04$). Excluded participants were also slightly older (51.2±14.2 vs. 53.8±15.9 years, $P<0.001$), differed in relation to gender distribution (% men; 45.3% vs.

42.2%, *P*=0.03) and had a higher prevalence of known diabetes (3.8% vs. 8.1%, *P*<0.001) and history of stroke, angina or myocardial infarction (12.0% vs. 7.9%, *P*<0.001).

INSERT TABLE 1 ABOUT HERE

Associations of TV viewing time with Health-Related Quality of Life

Each 1-hour per day increment in TV viewing time was associated with lower physical (-0.54 ([95% CI: -0.76, -0.34]) and mental (-0.41 [-0.70, -0.12]) component summary scores and the vitality sub-score (-0.51 [-0.81, -0.21]). Adjustment for leisure-time physical activity had minimal attenuating effects on each physical and mental summary score and vitality (Table 2). The physical component summary score and vitality sub-score were partially attenuated following adjustment for waist circumference, however all remained statistically significant (*P*≤0.01).

INSERT TABLE 2 ABOUT HERE

A significant gender interaction (*P*=0.03) was observed for the association of TV viewing time with vitality, with a significant trend and dose-response relationship observed across the tertiles of TV viewing time in men only (Figure 1). Compared to the participants meeting the physical activity guidelines (≥150 min/wk) and reporting the lowest TV viewing time (referent category), those not meeting the guidelines and reporting the highest TV viewing time had the lowest physical and mental wellbeing and vitality scores (Figure 2; *P*<0.001). Those reporting the highest TV viewing had lower mental wellbeing regardless of meeting or not meeting physical activity guidelines (*P*<0.001).

INSERT FIGURES 1 AND 2 ABOUT HERE

DISCUSSION

In this large population based cross-sectional study of Australian adults, higher TV viewing time was associated with lower physical and mental wellbeing and vitality, which persisted when controlling for leisure-time physical activity and waist circumference. These findings are broadly in contrast to previous studies that have examined joint physical activity and screen-time (i.e. TV and/or computer watching) associations with obesity [42] and metabolic health or risk biomarker outcomes [6, 30, 43, 44]; in those studies, many of the relationships identified were attenuated significantly by physical activity and/or adiposity. Interestingly, gender differences for the TV viewing time and vitality relationships in the present study contrast with that of previous observations for cardio-metabolic outcomes, in which findings were shown to be stronger for women [6, 29-31].

Associations of TV viewing time with physical and mental wellbeing and vitality have received only limited research attention [22]. Vallance and colleagues [45] showed inverse associations of overall objectively-measured sedentary time with health-related quality of life in a sample of 375 older men (≥55 years), after adjusting for moderate-to-vigorous physical activity time. However, the findings only held for weekend sedentary time and not for sedentary time on weekdays. In another study, higher levels of self-reported moderate-to-vigorous physical activity and lower levels of self-reported total sitting time were independently associated with slightly different outcomes of perceived "excellent health" and quality of life in the large, cross-sectional 45 and up study [28].

Our findings are broadly consistent with those of Davies and colleagues [46], who examined associations of total screen time (TV and computer) and physical activity with health-related quality of life (self-rated health, 'unhealthy days' and 'activity limitation days' over the last 30 days – HRQOL-4 instrument) in a smaller sample of 3,444 Australian men and women. Those who were physically inactive and who also reported high screen-time had lower health-related quality of life compared to those who reported being sufficiently active with low screen time – suggesting potential synergistic effects of meeting activity guidelines while also reducing screen time. In our large sample of Australian adults, compliance with the recommended public health guidelines for physical activity (≥150 min/wk) appeared to provide some protection across the tertiles of TV time examined, for physical wellbeing and vitality, but not for mental wellbeing. In general, participants not meeting the physical activity guidelines, and with the highest TV viewing time, displayed the lowest vitality and the lowest physical and mental component summary scores – a difference (>3 points

difference on SF-36 scores above 40) that has previously been defined as minimally important [47].

In slight contrast to our findings, where we controlled for total leisure-time physical activity, Ellingson and colleagues [14] reported that despite high engagement in sedentary behaviours, meeting physical activity guidelines was associated with higher levels of vitality (using the SF-36 vitality scale). However, they also found that those classed as insufficiently active (<150 min/wk), who also spent less time sedentary (≤1 hour per day, measured by accelerometer), had significantly lower levels of fatigue [14], suggesting that both increasing physical activity and reducing sedentary behaviour may be important to consider for fatigue and vitality. Again, while an objective measurement of activity was used, it should be noted that, unlike the present study, the sample comprised a relatively small sample of younger women; hence gender differences were not able to be examined.

It is important to consider the potential for bi-directional relationships of TV viewing time and physical and mental wellbeing and vitality, given the cross-sectional nature of this study and others. For instance, it could also be that those with poorer physical and mental wellbeing and vitality are more likely to engage in sedentary behaviours or vice-versa. Nonetheless, in their prospective study, Balboa and colleagues [48] reported sitting time to be significantly associated with poorer SF-36 outcomes of physical functioning, role physical, bodily pain, vitality, social functioning. Notwithstanding the smaller sample size and the significant participant losses at follow-up, these prospective findings provide an indication that higher levels of time spent in sedentary behaviours may contribute towards poorer physical and mental wellbeing and vitality. Further longitudinal studies are important to elucidate the temporal nature of such relationships.

It has been suggested that sedentary behaviours, particularly TV viewing and computer use, can reduce direct interpersonal communication with friends and family [49], increasing the risk of depression, mental health problems and stress [18, 19, 22, 23, 50]. Furthermore, excessive amounts of TV viewing time have been found to be associated with obesity [51, 52], which may play a mediating role in these relationships. Prolonged sitting has also been linked to musculoskeletal issues in the workplace and to debilitating conditions such as lower back pain [53, 54] – both of which may potentially lead to decreased mobility, physical function [55] and, ultimately, loss of engagement in physical activity and increased risk of chronic disease. Thus, given that more than twice the number of men and women were

engaged in full/part-time work, it could also be speculated that the effects of higher workplace sitting (though not specifically measured in this study) in addition to TV viewing time could contribute to a lowering of physical and mental [56] wellbeing and vitality, particularly since the total TV viewing time was relatively similar between the genders.

Different sedentary behaviours may differ in their association with health outcomes. For instance, recent studies have reported that high TV viewing, when compared with other sedentary behaviours such as reading or computer use, has deleterious relationships with cardiometabolic diseases [57], with a higher likelihood of being overweight, having greater psychological distress and not engaging in moderate-to-vigorous physical activity [58]. An inference might be that TV viewing time – interpreted as a more passive and less cognitively demanding sedentary behaviour – may need to be targeted in future interventions for physical and mental health outcomes. However, further research on this matter is needed; the strength of relationships identified with TV time is likely to be influenced by the higher accuracy with which it can be reported, relative to other sedentary behaviours [59]. Ideally, longitudinal study designs are required to strengthen the potential for causal inference [60].

When considering the implications of these findings, extrapolation of the observed regression coefficients in this study broadly suggests that approximately 6 or more hours of TV viewing per day could have a meaningful impact. Importantly, in light of the high volumes of TV viewing time that are observed in population studies [61, 62], the deleterious associations of TV viewing time with adults' wellbeing and vitality observed are concerning and warrant further investigation. This is particularly when taking into account determinants of and treatments for health conditions that include symptoms of reduced mental and physical wellbeing and vitality.

Study strengths and limitations

Strengths of this study include the large, population-based sample of both men and women. While adjustment was made for multiple confounders, it is possible that other factors may be relevant, particularly given the complex and multi-factorial nature of health-related quality of life measurement. For example the co-morbidities measured may provide limited information on the severity and complications of illnesses experienced by participants. Other limitations include the cross-sectional design, which precludes inferences about direction or causality of associations, and the reliance (as with all health-related quality of life measurement) on self-reported measures.

Conclusions

In this large population-based study we found TV viewing time to be associated adversely with physical and mental wellbeing and vitality, even after controlling for total leisure-time physical activity and waist circumference. Intriguingly, associations of TV viewing time with vitality were present only in men and meeting the physical activity guidelines was only partially protective for mental wellbeing, in the context of high TV viewing time. Future prospective studies and the measurement of these aspects of health-related quality of life in intervention trials could provide insights into potential causal relationships. It would also be informative to examine the roles of other domains of sedentary behaviour (for example, workplace sitting); relationships with metabolic and mental health indices; the potential protective role physical activity; and, what might underlie the gender variations that we observed.

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Table 1: Demographic, behavioural and cardiometabolic characteristics of participants according to gender, including exposure and outcome variables.

	Men	**Women**	***P***
Participant attributes:			
Gender	4483	5424	
Age (years)	51.5 (51.1, 51.9)	51 (50.6, 51.4)	0.02
Waist circumference (cm)	97.6 (97.2, 97.9)	85.2 (84.9, 85.6)	<0.001
Menopausal/post-menopausal (%)		54.8	
Higher education/University (%)	62.5	69.3	0.001
Employed full-time/part-time (%)	60.8	28.6	<0.001
Marital Status (%)			0.18
Married or de facto	81.0	73.4	
Widowed	2.4	9.6	
Divorced or Separated	6.9	10.3	
Never Married	9.7	6.7	
Behavioural attributes:			
Television viewing time (hr/day) [a]	2.0 (1.9, 2)	1.8 (1.8, 1.8)	<0.001
Leisure-time physical activity (min/wk) [a]	330.8 (319.9, 341.7)	228.2 (220.7, 235.8)	<0.001
% Insufficiently active (<150 min/wk)	41.6	52.5	-
% Sufficiently active (≥150 min/wk) [b]	58.4	47.4	-
Diet quality index (DQI-R, 1-100) [c]	59.9 (59.5, 60.3)	65.5 (65.1, 65.8)	<0.001
Co-morbidities:			
Known diabetes (%)	4.7	3.1	0.10
History of cardiovascular disease (%, stroke, angina, heart attack)	9.9	6.3	0.35
Quality of Life:			
Physical Component Summary Score (PCSS, 1-100)	49.7 (49.5, 50)	49 (48.7, 49.2)	0.001
Mental Component Summary Score (MCSS, 1-100)	49.3 (49, 49.6)	48.3 (48, 48.6)	0.003
Vitality Sub-score (VT, 1-100)	44.8 (44.5, 45.1)	42.9 (42.6, 43.2)	<0.001

Data are mean (95% CI) or %. [a]Based on self-report data using the timeframe of the most recent 7 days. [b]Based on the minimum recommended public health guidelines for physical activity (≥150 min per week). [c]Based on a revised scale of 1–100, with 100 representing high diet quality.

Table 2: Regression coefficients of TV viewing time (h/day) with physical (PCSS) and mental (MCSS) component summary score and vitality (VT) sub-score variables for the pooled sample.

Model	PCSS	MCSS	VT
A	-0.77 (-0.97, -0.58)***	-0.56 (-0.83, -0.30)***	-0.67 (-0.93, -0.40)***
B	-0.56 (-0.77, -0.34)***	-0.41 (-0.70, -0.12)**	-0.51 (-0.81, -0.21)**
C	-0.54 (-0.76, -0.33)***	-0.40 (-0.69, -0.11)**	-0.49 (-0.78, -0.21)***
D	-0.42 (-0.65, -0.19)***	-0.40 (-0.69, -0.12)**	-0.42 (-0.70, -0.13)**

Data are β coefficients (95% CI). *$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.
Model A: adjusted for age only.
Model B: adjusted for age, gender, education, diet quality, employment status, marital status, diabetes, history of cardiovascular disease (and menopausal status for women only).
Model C: adjusted for all covariates plus leisure-time physical activity.
Model D: adjusted for all covariates plus leisure-time physical activity and waist circumference.

Figure captions:

Figure 1: Associations of vitality sub-score with tertiles of TV viewing time for men (■) and women (▵). Cut points for TV viewing time (h/day) in men: 1.30, and 2.31; and women: 1.07, and 2.01. Data are presented as marginal means (95% CI) adjusted for age, education, diet quality, employment status, marital status, diabetes, history of cardiovascular disease, total physical activity time and waist circumference. Sex interaction presented in the box. *P* values for trend and between individual tertiles of TV viewing time from reference category (T1) are derived from natural logarithm of these values. *$P \leq 0.05$.

Figure 2: Associations of physical (PCSS), mental (MCSS) component summary scores and vitality sub-score with tertiles of TV viewing time for participants engaged in physical activity ≥150 min/wk (▵) and ≤150 min/wk (●). Cut points for TV viewing time (h/day) for those categorised as insufficiently active: 1.16, and 2.25 h/day; and sufficiently active: 1.18, and 2.21 h/day. Data are presented as marginal means (95% CI) adjusted for age, sex, education, diet quality, employment status, marital status, diabetes, history of cardiovascular disease, and waist circumference. *P* values from reference category, which represents sufficient physical activity and low TV viewing time, are derived from natural logarithm of these values. *$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.

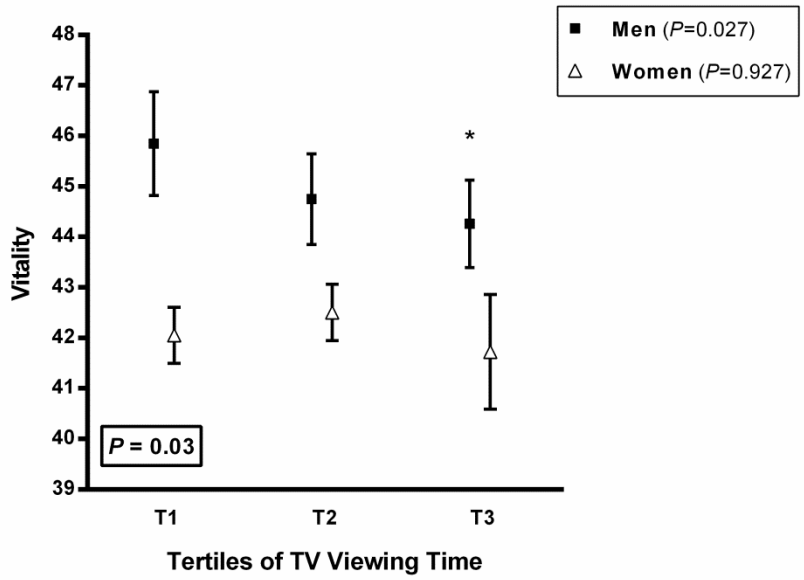

Figure 1

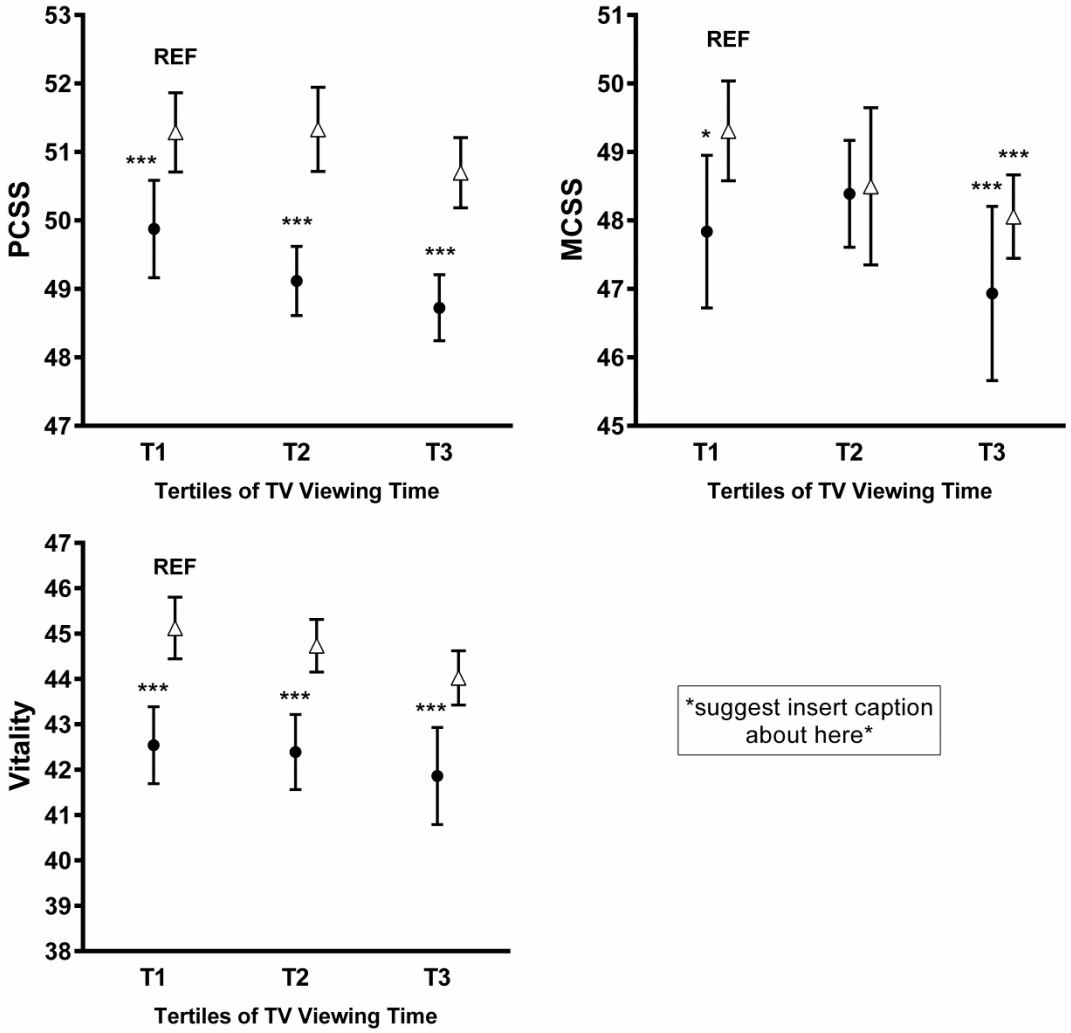

Figure 2

HIGHLIGHTS

- TV time was associated adversely with physical & mental wellbeing and vitality.
- A relationship with vitality was found for men, but not for women.
- With high TV time, physical activity only partially protective for mental wellbeing.
- Further (particularly prospective) studies are needed on gender differences.