Associations between television time and activPAL-measured duration and pattern of sedentary time among pregnant women at risk of gestational diabetes in the UK

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Abstract

Background: Television time is associated with poor cardiometabolic health outcomes. This finding is commonly attributed to duration of sitting or patterns of sitting associated with high TV time but there is very little evidence on this link. **Methods**: Pregnant women (n=167) at risk of gestational diabetes wore an activPAL accelerometer and self-reported their usual TV time in the second trimester. Generalized linear mixed models were used to compare objectively measured total sedentary time (ST), prolonged ST (bouts ≥30 minutes), and breaks in ST for all hours and evening hours (6pm-11pm) between those with high (≥2h/day) and low TV time. **Results**: Over all waking hours, those with high TV time had fewer breaks in ST than those with low TV time (exp(*b*) 0.92 (95%CI 0.86, 0.998)); there were no differences in total ST or prolonged ST between the two groups. Those with high TV time had significantly higher evening ST (*b*=9.9 (95%CI 0.5, 19.2)); there were no differences in prolonged ST or breaks in ST during evening hours. **Conclusions**: These findings suggest that high TV time may be associated with higher evening ST and fewer breaks in ST. The link between TV time and sitting patterns requires further investigation.

Keywords: sedentary time, television time, activPAL

Introduction

Television time is consistently linked with poor health outcomes, including all-cause mortality and incident type 2 diabetes[1]. Within epidemiological studies, the associations between television time and cardiometabolic health outcomes are generally interpreted to be effects of sitting. However, the association between TV time and poor health outcomes is stronger than the association between total sitting time[1-3] or time spent sitting in other contexts[4]. Discussions of possible explanations for the relatively large effects of TV time

compared to total sedentary time are ongoing and speculative. While the possibility of confounding effects by socioeconomic position[5], or factors such as snacking[1], have been put forward as potential explanations, the type of sitting associated with TV time may play an important role. For example, based on experimental evidence showing that breaking up sitting is associated with lower glucose and insulin levels compared to uninterrupted bouts of sitting[6], it has been suggested that watching TV might be associated with prolonged ST, and be detrimental for that reason[1,2,7]. It has also been suggested that the timing of TV (in the evening) might interfere with postprandial glucose metabolism[1,2]. However, to our knowledge, these possibilities have not been empirically tested.

The aim of this paper is to compare the duration and patterns of sedentary time between those with high and low TV time among a sample of pregnant women with a risk factor for gestational diabetes in the UK.

Methods

Study sample

Participants were pregnant women with a risk factor for gestational diabetes (i.e., BMI ≥30 at 8 weeks' gestation, previous gestational diabetes, family history of diabetes, previous macrosomia, or ethnicity associated with high diabetes prevalence) with a singleton pregnancy who were enrolled in a study examining associations between sedentary time and incident gestational diabetes[3]. Participants were recruited from two NHS hospitals in the North East of England when they attended the clinic for their 12-week ultrasound scan. A total of 326 women were recruited; 167 provided complete data sets (sedentary time, TV time, and all covariates) and were used as the analytical sample; reasons for withdrawal and incomplete data are detailed elsewhere[3]. Ethics approval was provided by the South Central

Oxford B NHS Research Ethics Committee; all participants provided written informed consent prior to participation.

Measures

Sedentary time was measured using the activPAL3 which is the gold standard for the measurement of sedentary time[8] and sit-to-stand transitions ('breaks')[9] in free-living contexts. The activPAL was worn by participants for 24 hours per day for seven days at 20 weeks' gestation (second trimester). During the wear period, participants were asked to record the times they went to bed each night and rose each morning on provided sleep diaries. activPAL data were processed via automated algorithm[10] with manual correction against the sleep diaries[3]. Data sets were considered valid if they contained at least four 24-hour days of measurement[11]. We did not require one of those days be a weekend day, although 97% of participants who provided four valid measurement days provided at least one weekend day. Sedentary time (minutes), prolonged sedentary time (uninterrupted bout of sedentary time lasting ≥30 minutes[11]), and breaks in sedentary time (number of sit-to-stand transitions) were the outcome variables of interest.

At the time of accelerometer fitting (20 weeks' gestation), participants were also asked to report the amount of time they usually spent watching television per day in the second trimester (none, <30 minutes, 30 minutes to less than 2 hours, 2 hours to less than 4 hours, 4 hours to less than 6 hours, ≥6 hours). Responses were dichotomized as less than or ≥2 hours per day as ≥2 hours of daily television time has been linked with poor health outcomes[3,12].

Participants provided demographic information about themselves on the study enrolment form. BMI (from approximately 8 weeks' gestation) was extracted from medical records.

Statistical analyses

Linear mixed models were used to examine the daily and hourly patterning of sedentary time with measurement day or hour, respectively, nested within participant as a random effect. Hourly analyses were limited to between 08:00 and 21:59 reflecting the mean rising time and bedtime in this sample based on participants' sleep diaries. Only hours which registered 60 minutes of waking wear were included in analyses.

The associations between TV time and total sedentary time were assessed using linear mixed models (sedentary time measurement day nested within participant), adjusted for waking accelerometer wear time and recruitment site (Model 1) and additional adjustment for age and BMI (continuous variables), marital status (married/cohabiting or not), children at home (any or none), and smoking status (any smoking during this pregnancy or not) (Model 2). Similar models were constructed for prolonged sedentary time (generalized linear mixed model with binary outcome dichotomized at the median due to non-normal distribution) and breaks in sedentary time (zero-truncated Poisson model). Analyses were repeated for evening hours only (6pm to 11pm), adjusted for evening waking time. We used the cutoff of 11pm instead of 10pm in these analyses to avoid truncating any potentially important variation in evening waking/sedentary time; as the vast majority of the sample (88%) were usually in bed by 11pm based on sleep diaries, we did not extend our analyses beyond this time.

Results

The mean (SD) age and BMI of the sample were 31 (5) years and 34.6 (5.6) kg/m^2, respectively. The mean sedentary time for the sample was 577 minutes (SD=148.6) per day, which was 65% of waking time. Sedentary time did not significantly differ across days of the

week (p=0.10). Estimated marginal means for daily sedentary time (Figure 1a) indicated that Sunday had the highest (598 (95%CI 552, 644) minutes) and Monday had the lowest (564 (95%CI 517, 613) minutes) sedentary time. When hourly sedentary time was plotted (all days combined), the majority of each waking hour (between 8am and 10pm) was spent sedentary (Figure 1b). The waking hours with the highest proportion of sedentary time (>45 minutes per hour) occurred between 8pm and 10pm (Figure 1b). Just over a third of the sample (n=60, 36%) reported high (≥2h/day) TV time.

The association between TV time and total sedentary time was non-significant (Table 1). Estimated marginal means indicated that the sedentary time of those with high and low TV time was 597 (95%CI 543, 651) and 567 (95%CI 528, 607) minutes per day, respectively. There was no difference in likelihood of high prolonged sedentary time between those with high versus low TV time (Table 1). Those with high TV time had fewer breaks in sedentary time (in the fully adjusted model) compared to those with low TV time (Table 1, Model 2). Estimated marginal means indicate that those with high and low TV time had 47 (95%CI 44, 51) and 51 (95%CI 48, 55) breaks in sedentary time per day, respectively.

When considering only evening hours (6pm to 11pm), those with high TV time had significantly higher sedentary time in the evening than those with low TV time (Table 1). There was no difference in likelihood of high prolonged evening sedentary time between the two groups (Table 1). There was also no difference in the number of breaks in sedentary time in the evening hours (Table 1).

Discussion

In this sample of pregnant women, sedentary time was the highest in the evenings and on Sundays. Those with higher television time (≥2 hours per day) had significantly higher sedentary time in the evenings (after 6pm) than those with low television time and had fewer breaks in sedentary time across the entire day. There were no differences in total sedentary time, prolonged sedentary time (in total or in the evenings), or evening breaks in sedentary time between the two groups.

The relationship between TV time and total sedentary time has been previously examined in samples of adults[13,14], including activPAL-measured sedentary time[14]. Both studies reported weak but significant correlations between self-reported TV time (as a continuous variable) and objectively measured sedentary time (ρ=0.22 (95%CI 0.20, 0.25)[13] and (ρ=0.16 (95%CI 0.09, 0.24)[14]). In our sample, those with high TV time had about 30 minutes more sedentary time per day than those with low TV time, but this was not statistically significant.

To our knowledge, no other studies have investigated associations between TV time and prolonged sedentary time or breaks in sedentary time in free-living contexts. Our findings suggest that those with higher TV time had fewer breaks in sedentary time across the day than those with low TV time. However, this difference equates to roughly 4 fewer breaks per day; the significance of this difference for health is unclear. There were no differences in the likelihood of high prolonged sedentary time between the two groups.

No studies that we know of have investigated the relationship between TV time and patterns of sedentary time in the evening. In this sample, evening total sedentary time was higher (by about 9 minutes per evening) among those with high TV time compared to among those with low TV time. There was no difference in high prolonged sedentary time or breaks in

175 sedentary time in the evening between those with high and low TV time. This suggests that
176 while those with high TV time had higher total sedentary time in the evening, it was not
177 necessarily prolonged in nature.
178
179 While these data are based on a sample of pregnant women at high risk of gestational
180 diabetes, their daily sedentary time does not appear substantially different from the sedentary
181 time reported in studies that used similar methods (activPAL with continuous-wear protocol)
182 among samples of adults. For example, the mean daily sedentary time in this sample (577
183 minutes per day) is similar to the mean sedentary time reported among population-based
184 samples of adults (men and women) in the Netherlands (567 minutes)[15] and women in
185 Australia (513 minutes)[14]. The prevalence of high TV time in this sample (36%) is lower than
186 the prevalence of high TV time (≥2 hours per day) reported in a population-based sample of
187 women in Northern Ireland (44%)[16], suggesting the TV time in this sample is not unusually
188 high. Furthermore, participants in this study wore the activPAL in the middle of their second
189 trimester (20 weeks' gestation), the stage of pregnancy usually associated with fewer
190 pregnancy symptoms (e.g., nausea, fatigue, changes in body size and shape)[17] and higher
191 physical activity levels[18] compared to earlier and later stages of pregnancy.
192
193 Taken together, these results contribute to the ongoing debate concerning whether the
194 associations between TV and poor health outcomes may be linked to the way in which sitting
195 is patterned. Our finding that those with high TV time had higher sedentary time in the
196 evening provides some support to the hypothesis that TV might be detrimental because it is
197 associated with more sitting in the evening, which may potentially affect postprandial glucose
198 metabolism[1]. Furthermore, it has been suggested that sitting time while watching TV may be
199 prolonged, and detrimental for that reason[1,7]. While television time was not associated with

higher prolonged sedentary time in this sample, it was associated with fewer breaks (~4) in sedentary time across the entire day. While it is unclear whether this small difference is clinically meaningful, it does lend some support to the hypothesis that those with high TV time have fewer sit-to-stand transitions.

Study limitations and strengths

The findings of this study should be interpreted in light of its limitations. We did not have a continuous measure of TV time which impeded a more precise estimation of its association with accelerometry variables. The size of our sample was powered to test associations between sedentary time and gestational diabetes[3] and may be underpowered for detecting differences in sedentary patterns between the two groups. The generalizability of the study's findings may be limited as the sample was pregnant women with a risk factor for gestational diabetes. The main strength of this study is the use of a gold-standard measurement of sitting in free-living contexts.

Conclusion

In this sample, those with high TV time had higher evening sitting time and fewer breaks in sedentary time throughout the day. There were no significant differences in total sitting time, prolonged sitting time, or evening breaks in sedentary time between the two groups. Further research is needed to understand the role that patterns of sitting while watching TV might contribute to links between TV time and poor health outcomes.

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293 **Table 1**. Associations between high versus low TV time and activPAL-measured variables

294 (n=167)

	Model 1	**Model 2**
All waking hours		
Total sedentary time (min/day)	*b (95%CI)*	*b (95%CI)*
	29.7 (-0.91, 60.4)	27.8 (-2.63, 58.3)
High prolonged ST (>137.1min)	*OR (95%CI)*	*OR (95%CI)*
	1.17 (0.82, 1.69)	1.20 (0.83, 1.73)
Breaks in ST (number/day)	*exp(b) (95%CI)*	*exp(b) 95%CI)*
	0.93 (0.86, 1.01)	0.92 (0.86, 0.998)*
Evening hours (6pm to 11pm)		
Total sedentary time (min/day)	*b (95%CI)*	*b (95%CI)*
	9.34 (0.06, 18.60)*	9.86 (0.50, 19.20)*
High prolonged ST (>53.9min)	*OR (95%CI)*	*OR (95%CI)*
	1.11 (0.79, 1.56)	1.15 (0.82, 1.63)
Breaks in ST (number/day)	*exp(b) (95%CI)*	*exp(b) 95%CI)*
	0.95 (0.87, 1.04)	0.95 (0.87, 1.04)

295 * $p<0.05$

296 In all models, referent group is <2h/day TV time

297 Model 1 adjusted for waking time and recruitment site

298 Model 2 additionally adjusted for age, BMI, children, marital status, smoking status

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Figure 1. Patterning of total sedentary time by (a) day of the week and (b) hour of the day (waking hours only). The dashed line in (a) represents the grand mean.