Short Report: Epidemiology

Television viewing time and risk of incident diabetes mellitus: the English Longitudinal Study of Ageing

L. Smith[1] and M. Hamer[2]

[1]Health Behaviour Research Centre, University College London, London, UK and [2]Physical Activity Research Group, Department of Epidemiology and Public Health, University College London, London, UK

Abstract

Aim   To investigate the longitudinal association between television viewing time and risk of incident diabetes mellitus in an elderly sample of adults in England.

Methods   Analyses of data from the English Longitudinal Study of Ageing. At baseline (2008), participants reported their television viewing time and physical activity level. Diabetes mellitus was recorded from self-reported physician diagnosis at 2-year follow-up. Associations between television viewing time and combined television viewing time and physical activity level with risk of incident diabetes mellitus at follow-up were examined using adjusted logistic regression models.

Results   A total of 5964 participants (mean $\pm$ SD age 65 $\pm$ 9 years at baseline, 44% male) were included in the analyses. There was an association between baseline television viewing time and risk of incident diabetes mellitus at 2-year follow-up ($\geq$ 6 h/day compared with <2 h/day; odds ratio 4.27, 95% CI 1.69, 10.77), although the association was attenuated to the null in final adjusted models that included BMI. Participants who were inactive/had high television viewing time at baseline were almost twice as likely to have diabetes mellitus at 2-year follow-up than those who were active/had low television viewing time (fully adjusted odds ratio 1.94, 95% CI 1.02, 3.68), although active participants reporting high television viewing were not at risk.

Conclusion   Interventions to reduce the incidence of diabetes in the elderly that focus on both increasing physical activity and reducing television viewing time might prove useful.

Diabet. Med. 31, 1572–1576 (2014)

Introduction

The prevalence of diabetes mellitus in England has increased from ~1.4 million cases in 1996 to 2.9 million cases in 2012 (www.diabetes.org.uk). This increase may be partially explained by an ageing population and improved detection of undiagnosed diabetes mellitus, as well as by an increase in the number of people who are overweight or obese [1] and decreasing population physical activity levels [2]. Moreover, a growing body of literature is emerging that suggests increasing sedentary time may also be contributing to this epidemic [3].

Television viewing is an important component of sedentary leisure time and is distinct from other sedentary behaviours in that it is passive and encourages prolonged periods of sitting. Furthermore, television viewing is likely to influence behaviour beyond the time spent in front of the television. For example, it may influence dietary habits by encouraging an increased consumption of energy-dense food [4]. In a recent meta-analysis of four prospective studies, a pooled relative risk of 1.20 (95% CI 1.14, 1.27) was observed for developing Type 2 diabetes mellitus per 2 h of television viewing per day in adults [3]; however, studies in the meta-analysis have a number of important limitations. The studies only included samples of the general adult population; given that the average adult aged >65 years in England watched more television daily than any other age group, in 2011 (www.stakeholders.ofcom.org.uk), studies are needed specifically in older adults (>65 years), as this age group may be at greatest risk. Not all studies identified in the meta-analyses controlled for BMI, which limits interpretation of findings because BMI is likely to attenuate the effect size between television viewing time and Type 2 diabetes mellitus. Finally, not all the identified studies investigated the *combined* effect of television viewing time and physical

Correspondence to: Lee. Smith. E-mail: lee.smith@ucl.ac.uk

What's new?

- This is the first study to investigate the longitudinal association between television viewing time and risk of incident diabetes mellitus in an elderly sample of adults in England.

- Participants who were classified as inactive/having high television viewing time at baseline were twice as likely to have diabetes mellitus at 2-year follow-up than those who were classified as active/having low television viewing time.

- Interventions to reduce the incidence of diabetes in the elderly that focus on both increasing physical activity and reducing television viewing time might prove useful.

activity level on risk of incident diabetes mellitus. Based on previous literature, we hypothesized that the risk of diabetes mellitus would only be observed in participants who had high television viewing time in combination with inactivity.

The present analysis aims to investigate the longitudinal association between television viewing time, physical activity level and risk of incident diabetes mellitus, using data from the English Longitudinal Study of Ageing (ELSA).

Materials and methods

Study sample and procedures

ELSA is an ongoing cohort study that contains a nationally representative sample of the English population living in households [5]. The ELSA cohort consists of men and women born on or before 29 February 1952. The sample was drawn using multistage stratified probability sampling, with post-code sectors selected at the first stage and household addresses selected at the second stage. For the purposes of the present analyses, data collected during wave 4 (2008–2010) were used as the baseline, as this was the first occasion on which information on television viewing was gathered. Participants gave full informed written consent to participate in the study and ethical approval was obtained from the London Multicentre Research Ethics Committee.

Baseline television viewing and physical activity

Participants were asked 'How many hours of television do you watch on an ordinary day or evening, that is, Monday to Friday' and 'How many hours of television do you normally watch in total over the weekend, that is, Saturday and Sunday'. Average daily time spent watching television was calculated as [(weekday television time x 5) + (Weekend television time)]/7. For analysis purposes, average daily television viewing data were classified into four roughly

equal categories (<2 h/day, 2–4 h/day, 4–6 h/day and ≥6 h/day).

Participants were asked how often they took part in vigorous, moderate- and low-intensity physical activity, using prompt cards to help them interpret different physical activity intensities. Response options were: more than once a week, once a week, one to three times a month and hardly ever/never. Physical activity was further categorized into three categories: inactive; moderate activity at least once a week; and vigorous activity at least once a week (for more information on this measure see Hamer *et al.* [6]). The physical activity and television viewing measures have been shown to have excellent convergent validity in grading a plethora of psychosocial, physical and biochemical risk factors [6–8].

Incident diabetes mellitus

Diabetes mellitus was recorded from self-reported physician diagnosis, which has been previously validated in ELSA [9]. Incident cases of diabetes mellitus were recorded at 2-year follow-up (wave 5; 2010–2011). Participants reporting diabetes mellitus in any previous assessments ($n = 540$) were removed from the present analyses. Those participants reporting a diabetes mellitus diagnosis at baseline had higher HbA_{1c} levels compared with those who did not [56 mmol/mol (7.3 ± 1.3%) vs 40 mmol/mol (5.8 ± 0.5%); $P < 0.001$], thus providing further validity of the self-reported measure in this sample.

Covariates

Age, sex and chronic illness were self-reported. Trained interviewers asked questions on cigarette smoking (current, previous or non-smoker), alcohol intake (daily, at least once a week, monthly, rarely, never), and depressive symptoms (using the eight-item Centre of Epidemiological Studies Depression scale). Disability was assessed based on participants' responses to interviewer questions on perceived difficulties in six basic activities (e.g. difficulty dressing) and seven instrumental activities of daily living (e.g. difficulty preparing a hot meal [10]). Participants with difficulties in one or more activities were considered to have some degree of disability. Trained research nurses measured participants' height and weight (whilst participants wore light clothing). BMI was calculated in kg/m^2.

Statistical analyses

Characteristics of the study population at baseline were analysed using descriptive statistics. Next, we examined associations between baseline television and combined baseline television and physical activity level with risk of incident diabetes mellitus at 2-year follow-up using logistic regression models. We adjusted all models for pre-specified covariates.

Results

A total of 10 603 participants attended the baseline assessment (wave 4), of whom 6653 (62.7%) had complete baseline data after exclusion of 540 participants with existing diabetes mellitus. Of these, 689 participants (10.4%) were lost to follow-up, leaving a final analytical sample of 5964 participants (aged 64.6 ± 9.0 years, 44.4% male). Compared with those in the final sample, baseline participants subsequently excluded for any reason were older, viewed more television, were less physically active, reported more depressive symptoms, had a lower BMI, and were more likely to report a disability (all $P < 0.001$). Participants reported watching television on average for 5.2 ± 4.0 h/day, although over a quarter of the sample (26.8%) watched television > 6 h/day.

Table 1 shows the descriptive characteristics of the sample in relation to television viewing at baseline. Participants who watched more television tended to have less healthy profiles in terms of lower physical activity, smoking, greater chronic illness and disability and a higher prevalence of obesity and depressive symptoms.

Logistic regression models, adjusted for age and sex, showed a linear increase in risk of diabetes with increasing television viewing (Table 2). When models were adjusted for additional covariates, including both physical activity and BMI, the strength of the association was considerably attenuated and nonsignificant in the final model. Physical activity was inversely associated with risk of diabetes mellitus in a dose–response manner, although the association did not remain significant in the final model after adjusting for BMI. In the final set of analyses we examined combined associations of television viewing and physical activity with diabetes risk. Participants who were categorized as inactive/having high television viewing time were significantly more likely to develop diabetes mellitus at 2-year follow-up (age-/sex-adjusted odds ratio 3.20, 95% CI 1.72, 5.94) than those categorized as active/having low television viewing time (Table 2). When models were adjusted for additional covariates, including BMI, the strength of the association was reduced but remained significant (odds ratio 1.94, 95% CI 1.02, 3.68). Active participants viewing high television were not at increased risk.

Discussion

In this population-based longitudinal study of elderly adults in England, logistic regression models adjusted for age and sex show that those who watched the greatest amount of television at baseline were approximately four times as likely to develop diabetes mellitus at 2-year follow-up when compared with those who watched the least amount of television. This finding supports previous research carried out in Germany and the USA in general adult populations [3]; however, when models were adjusted for other covariates, including BMI, the association was attenuated to the null. Possible explanations for the lack of association are that BMI either confounds or mediates the relationship between television viewing time and risk of incident diabetes mellitus.

The present analysis also shows that physical activity modifies the association between television viewing and diabetes risk; participants who were inactive/had high television viewing time were at the greatest risk, even after adjusting for BMI. This association may be explained by the displacement of incidental physical activity with television viewing [11] and increased energy intake through eating energy-dense foods whilst watching television [4]. Moreover, it is well documented that physical activity reduces body weight, visceral fat accumulation and insulin resistance and improves glucose tolerance and lipid profiles, all of which may help protect against the onset of Type 2 diabetes mellitus [12]. In final adjusted models, those who were categorized as active/having high television viewing time were less likely to develop diabetes mellitus at 2-year follow-up than those who were categorized as inactive/having high television viewing time. This suggests that being physically active may provide health

Table 1 Baseline characteristics in relation to television viewing

	< 2 h/day (n = 642)	≥ 2 < 4 h/day (n = 2105)	≥ 4 < 6 h/day (n = 1616)	≥ 6 h/day (n = 1601)
Mean ± sd age, years	63.7 ± 9.2	64.2 ± 9.1	65.4 ± 9.1	64.8 ± 9.1
Men, %	52.6	47.0	41.6	40.3
Current smokers, %	5.6	10.4	12.1	18.9
Physically active*, %	45.6	39.1	29.5	24.5
Regular alcohol intake†, %	30.8	28.0	20.8	20.0
Chronic illness, %	43.6	45.6	51.7	52.9
Disability, %	16.8	16.0	21.4	29.2
Obese‡, %	17.0	24.5	33.1	36.2
Depressed§, %	10.0	8.3	11.8	16.9

*defined as vigorous activity at least once per week.
†defined as alcohol intake at least 5 times per week.
‡BMI ≥ 30 kg/m^2
§Centre of Epidemiological Studies Depression scale score ≥4

Table 2 Odds ratios for television viewing, physical activity and risk of incident diabetes over 2 years' follow-up in the English Longitudinal Study of Ageing among participants without any previous diagnosis of diabetes at baseline (N = 5964)

Television/Physical activity exposure	Cases, n/N	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Television viewing*				
<2 h/day	5/642	1.0 (reference)	1.0 (reference)	1.0 (reference)
≥2 to <4 h/day	35/2105	2.22 (0.87, 5.69)	2.03 (0.79, 5.22)	1.82 (0.71, 4.70)
≥4 to <6 h/day	40/1616	3.39 (1.33, 8.63)	2.73 (1.06, 6.99)	2.23 (0.86, 5.73)
≥ 6 h/day	49/1601	4.27 (1.69, 10.77)	3.19 (1.25, 8.13)	2.54 (0.99, 6.51)
P trend		0.002	0.043	0.181
Physical activity†				
Inactive	36/1022	1.0 (reference)	1.0 (reference)	1.0 (reference)
Moderate	67/2957	0.62 (0.41, 0.94)	0.81 (0.52, 1.25)	0.83 (0.54, 1.30)
Vigorous	26/1986	0.35 (0.21, 0.59)	0.55 (0.32, 0.97)	0.62 (0.36, 1.10)
P trend		<0.001	0.109	0.255
Combined television/ physical activity‡				
Active/low TV	12/1125	1.0 (reference)	1.0 (reference)	1.0 (reference)
Inactive/low TV	28/1641	1.64 (0.83, 3.25)	1.41 (0.71, 2.80)	1.29 (0.65, 2.58)
Active/high TV	14/874	1.56 (0.72, 3.40)	1.44 (0.66, 3.15)	1.29 (0.59, 2.83)
Inactive/high TV	75/2359	3.20 (1.72, 5.94)	2.42 (1.28, 4.56)	1.94 (1.02, 3.68)

TV, television viewing time; OR, odds ratio.
Active was defined as participating in vigorous activity at least once a week. High television viewing time was defined as watching >4 h/day.
Model 1: adjusted for age and sex; model 2: adjusted for age, sex, physical activity (or television viewing), smoking, alcohol, depressive symptoms, long-standing illness, disability (impairment in activities of daily living/instrumental activities of daily living). model 3: adjusted for age, sex, physical activity (or television viewing), smoking, alcohol, depressive symptoms, long-standing illness, disability (activities of daily living /|/ instrumental activities of daily living) + BMI category.
*Models 2 and 3 adjusted for physical activity;
†models 2 and 3 adjusted for television viewing;
‡television viewing and physical activity adjustments dropped from all models.

benefits even when an individual participates in a high amount of television viewing.

The strengths of the present analysis include its prospective design, its large population-based sample of elderly adults in England, and the adjustment for BMI; however, the low number of incident diabetes mellitus cases may have affected statistical power, as is reflected in the large confidence intervals of all exposure groups of television viewing time. One limitation of the present analysis is that data are based on self-report, which may have introduced bias. Another limitation is that it was not possible to adjust models for diet, as such data were not collected. With a limited 2-year follow-up period we cannot discount the possibility of reverse causation, but reverse causation is unlikely because we removed cases of prevalent diabetes at baseline and also adjusted for numerous indicators of health and function in our analyses. Also, in a sub-sample of participants at baseline, no cross-sectional association between television viewing and HbA$_{1c}$ was observed (data not shown), which suggests our main results were not biased by undetected diabetes. Individuals with long-standing illness, however, were included in the analyses. Long-standing illness may be a risk factor for diabetes mellitus and may also lead to more television viewing, and thereby may confound the identified associations.

In conclusion, in the present sample of elderly adults in England, high television viewing time combined with physical inactivity at baseline was associated with increased risk

of incident diabetes mellitus at 2-year follow-up. Interventions to reduce the incidence of diabetes in the elderly that focus on both increasing physical activity and reducing television viewing time might prove useful.

Competing interests

None declared.

References

1 Kahn SE, Hull RL, Utzschneider KM. Mechanisms linking obesity to insulin resistance and type 2 diabetes. *Nature* 2006; **444**: 840–846.

2 Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: a systematic review. *Diabetes Care* 2007; **30**: 744–752.

3 Grontved A, Hu FB. Television viewing and risk of type 2 diabetes, cardiovascular disease, and all-cause mortality: a meta-analysis. *JAMA* 2011; **305**: 2448–2455.

4 Lank NH, Vickery CE, Cotugna N, Shade DD. Food commercials during television soap operas: what is the nutrition message? *J Community Health* 1992; **17**: 377–384.

5 Steptoe A, Breeze E, Banks J, Nazroo J. Chort Profile: The English Longitudinal Study of Ageing. *Int J Epidemiol* 2013; **42**: 1640–1648.

6 Hamer M, Lavoie KL, Bacon SL. Taking up physical activity in later life and healthy ageing: the English longitudinal study of ageing. *Br J Sports Med* 2014; **48**: 239–243.

7 Hamer M, Stamatakis E. Screen-based sedentary behavior, physical activity, and muscle strength in the English longitudinal study of ageing. *PloS One* 2013; **8**: e66222.

8 Hamer M, Stamatakis E. Prospective study of sedentary behavior, risk of depression, and cognitive impairment. *Med Sci Sports Exerc* 2013.

9 Pierce MB, Zaninotto P, Steel N, Mindell J. Undiagnosed diabetes-data from the English longitudinal study of ageing. *Diabet Med* 2009; **26**: 679–685.

10 Katz S, Downs TD, Cash HR, Grotz RC. Progress in development of the index of ADL. *Gerontologist* 1970; **10**: 20–30.

11 Tucker LA, Bagwell M. Television viewing and obesity in adult females. *Am J Public Health* 1991; **81**: 908–911.

12 Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: the evidence. *Can Med Assoc J* 2006; **174**: 801–809.