Journal of Diabetes

Journal of Diabetes **2** (2010) 23–27

ORIGINAL ARTICLE

Television watching and incident diabetes: Findings from the European Prospective Investigation into Cancer and Nutrition–Potsdam Study*

Earl S. FORD,[1] Matthias B. SCHULZE,[2] Janine KRÖGER,[3] Tobias PISCHON,[3] Manuela M. BERGMANN[3] and Heiner BOEING[3]

[1]Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia, USA, [2]Public Health Nutrition Unit, Technische Universität München, Center of Life and Food Sciences, Freising; [3]Department of Epidemiology, German Institute for Human Nutrition (DIfE), Potsdam-Rehbrücke, Nuthetal, Germany

Correspondence
Earl S. Ford, Centers for Disease Control and Prevention, 4770 Buford Highway, MS K66, Atlanta, Georgia 30341, USA.
Tel: +1 770 488 2484
Fax: +1 770 488 8150
Email: eford@cdc.gov

*The findings and conclusions in this article are those of the authors and do not represent the official position of the Centers for Disease Control and Prevention.

Received 14 May 2009; revised 8 July 2009; accepted 19 July 2009.

doi: 10.1111/j.1753-0407.2009.00047.x

Abstract

Background: The aim of the present study was to examine whether the amount of time spent watching television is a potential risk factor for incident diabetes and to what extent this association may be explained by obesity.

Methods: We used data for 23 855 men and women from the European Prospective Investigation into Cancer and Nutrition–Potsdam Study. During an average of 7.8 years of follow-up, 927 participants developed diabetes. Incident diabetes was identified on the basis of self-report and was verified by contacting the patient's attending physician. The amount of time spent watching television was self-reported.

Results: The mean time that the participants who developed diabetes watched television was 2.4 h/week, compared with 2.0 h/week for those who did not develop diabetes ($P < 0.001$). After adjusting for age, sex, educational status, smoking status, alcohol use, occupational activity, physical activity, the intake of various foods, and systolic blood pressure, the adjusted hazard ratio for diabetes among participants who watched ≥4 h/day of television compared with those who watched <1 h/day was 1.63 [95% confidence interval (CI): 1.17–2.27]. After additional adjustment for waist circumference and body mass index, the hazard ratio was reduced to 1.14 (95% CI: 0.81–1.61).

Conclusions: In the present study, the amount of time spent watching television was an independent predictor of incident diabetes only in models that adjusted for sociodemographic characteristics, lifestyle behaviors, and systolic blood pressure. The attenuation of the association after adjusting for anthropometric measures may represent an explanatory mechanism for our findings.

Keywords: body mass index, diabetes, exercise, leisure activities, prospective studies, television.

Introduction

Inadequate physical activity is a well recognized risk factor for diabetes. Most prospective studies of diabetes have generally examined the associations between various forms of energy expenditure and incident diabetes. Less well understood is the association between sedentary behavior and incident diabetes. In two large cohort studies, the amount of television viewing was found to be a significant independent risk factor for developing diabetes.[1,2]

There are several reasons for focusing on the associations between television viewing and chronic conditions such as diabetes. First, cross-sectional and prospective studies have linked the amount of television viewing with an increased risk of obesity, a major risk factor for diabetes.[3,4] Second, television viewing has been associated with obesity and diabetes independently of physical activity.[1,2] Thus, the act of television viewing may denote more than the absence of physical activity. Third, messages to promote physical activity in the population may not only need to convince people to engage in adequate levels of physical activity but may also need to discourage excessive sedentary behavior. Finally, an increased risk of developing diabetes attributable to excess sedentary behavior has potential implications for clinicians and public health practitioners.

Few studies have examined the association between television watching and incident diabetes prospectively. Establishing these relationships in different countries and cultures is important, because the differences in attendant behaviors could affect the risk of adverse outcomes. Therefore, the aim of the present study was to examine data from a large German prospective study to address this association. Because the pathway from excessive television viewing to incident diabetes is likely to lead through obesity to a considerable extent, we hypothesized that any increase in the risk of diabetes from excessive television viewing would be attenuated by adjusting for anthropometric measures.

Methods

Study population

In the European Prospective Investigation into Cancer and Nutrition (EPIC)–Potsdam Study, Germany, men aged 40–65 years and women aged 35–65 years were the target of recruitment. In total, 27 548 subjects (16 644 women and 10 904 men) from the general population joined the study between 1994 and 1998.[5] The baseline examination included anthropometric measurements, a personal interview including questions on prevalent diseases, a questionnaire on sociodemographic and lifestyle characteristics, and a food frequency questionnaire. Follow-up questionnaires to identify incident cases of diabetes mellitus have been administered every 2–3 years since. The response rates for each of the waves of follow-up exceeded 90%. We also considered questionnaires that were part of the ongoing fourth wave of follow-up and were sent out until 31 January 2005. By 31 August 2005, 90% had been returned. Consent was obtained from all participants in the study and approval was given by the Ethical Committee of the State of Brandenburg, Germany.

Participants with diabetes at baseline were excluded from the analyses. Self-reported diabetes mellitus at baseline was evaluated by a physician using information on self-reported medical diagnoses, medication records, and dieting behavior. Uncertainties regarding a proper diagnosis were clarified with the participant or the treating physician. A total of 23 855 participants (9167 men, 14 688 women) who had complete information for the study variables were included in the analyses.

Ascertainment of incident diabetes

Potentially incident cases of diabetes were identified via self-reports of a diabetes diagnosis, diabetes-relevant medication, or dietary treatment due to diabetes. All potentially incident cases were verified by questionnaires that were mailed to the diagnosing physician asking about the date and type of diagnosis, diagnostic tests, and treatment of diabetes. Only cases with a physician diagnosis of Type 2 diabetes mellitus (T2DM; International Classification of Diseases, 10th Revision: E11; http://apps.who.int/classifications/apps/icd/icd10online/, accessed 27 July 2009) and a diagnosis date after the baseline examination were considered as confirmed incident cases of T2DM.

Assessment of television viewing

The amount of time each week that a participant spent watching television was assessed with the following question administered at baseline: "On average, how many h/day did you watch television during the last 12 months?"

Covariates

We included the following covariates from the baseline data collection: age, sex, educational status, smoking status, alcohol use, physical strain at work, physical activity (h/week of walking, gardening, bicycling, and performing sports), waist circumference, body mass index (BMI), systolic blood pressure (SBP), and intakes of red meat, coffee, whole-grain bread, fruits and vegetables, pizza, soda, cake, chips, dessert, total energy, total fat, saturated fat, protein, and carbohydrates. Information on educational attainment, smoking status, alcohol use, occupational activity, and physical activity was assessed with a self-administered questionnaire and a personal interview. The physical activity questions, which were developed for the EPIC study, included questions about bicycling (a common mode of transportation in the Potsdam area), sports activities, and gardening. The food frequency questionnaire in this study included 148 of the 158 food items originally tested for the German cohorts of the EPIC study.[6,7] Anthropometric measurement procedures followed standard protocols under strict quality control.

Statistical analyses

Differences in baseline characteristics by incident diabetes status were tested with Wilcoxon rank-sum tests for continuous variables. Linear trends for continuous variables across categories of time spent watching television were evaluated using linear regression analysis, and trends for categorical variables were assessed with the Cochran–Mantel–Haenzel test. Cox proportional hazards analysis was used to estimate hazard ratios (HRs) and the 95% confidence intervals (CI). Age was used as the primary time-dependent variable in all models, with entry time defined as the subject's age at recruitment and exit time as the date of diagnosis of diabetes, death, or return of the last follow-up questionnaire. All analyses were performed with SAS release 9.1 (SAS Institute, Cary, NC, USA).

Results

During 7.8 years of follow-up, 927 participants (534 men, 393 women) developed diabetes. Television viewing time ranged from 0 to 12 h/day. The mean time that participants who developed diabetes watched television was 2.4 h/day, compared with 2.0 h/day for those who did not develop diabetes ($P < 0.001$).

Significant positive associations were noted between the amount of time spent watching television and age, the percentage of women, the percentage of participants who had an occupation requiring heavy or very heavy physical strain, waist circumference, BMI, SBP, the intake of alcohol and several foods, and time (h/week) spent walking, gardening, and playing sport (Table 1). Furthermore, significant inverse associations were present for the percentage of participants receiving a university education, the percentage of participants who never smoked, the intake of whole-grain bread, fruits and vegetables, and bicycling.

Table 1 Unadjusted and age-adjusted baseline characteristics of 23 855 participants according to the amount of time spent watching television each day (European Prospective Investigation into Cancer and Nutrition–Potsdam Study, 1994–2005)

	Television viewing (h/day)					
	<1 (*n* = 2715)	1–<2 (*n* = 7135)	2–<3 (*n* = 8078)	3–<4 (*n* = 3992)	4+ (*n* = 1935)	*P* value
Age (years)	46.8	48.3	49.7	52.0	54.1	<0.001
Alcohol use* (g/day)	13.1	13.6	14.1	15.2	15.8	<0.001
Walking* (h/week)	7.8	7.7	7.9	8.5	9.3	<0.001
Bicycling* (h/week)	2.2	1.9	1.8	1.6	1.8	<0.001
Gardening* (h/week)	2.9	3.2	3.2	3.5	2.9	0.035
Sports* (h/week)	11.1	10.6	10.6	11.0	11.9	<0.001
Body mass index* (kg/m^2)	24.9	25.7	26.3	26.9	27.3	<0.001
Waist circumference* (cm)	82.4	84.5	86.0	88.2	89.0	<0.001
Systolic blood pressure (mmHg)*	125.3	128.3	129.2	130.3	130.5	<0.001
Daily intake of:						
Red meat* (g/day)	37.0	40.1	42.4	45.2	45.8	<0.001
Whole-grain bread* (g/day)	58.9	49.7	43.7	39.6	36.4	<0.001
Fruits and vegetables* (g/day)	250.6	247.8	243.8	231.5	230.1	<0.001
Coffee* (g/day)	396.4	407.0	421.6	436.8	446.3	<0.001
Soda* (g/day)	30.4	36.1	45.9	59.3	76.1	<0.001
Pizza* (g/day)	8.3	7.5	7.0	6.9	6.4	<0.001
Desserts* (g/day)	16.4	15.9	15.6	17.0	16.2	0.270
Cakes* (g/day)	61.0	62.1	62.5	66.5	67.8	<0.001
Chips* (g/day)	1.7	2.1	2.3	2.6	2.8	<0.001
Total fat* (g/day)	82.4	81.8	82.5	85.9	86.3	<0.001
Saturated fat* (g/day)	34.5	33.8	33.8	35.2	35.3	<0.001
Protein* (g/day)	74.6	74.9	75.4	78.1	77.8	<0.001
Carbohydrates* (g/day)	239.0	236.2	236.8	243.7	243.5	<0.001
Energy intake* (kJ/day)	8842.0	8792.6	8855.6	9177.6	9201.1	<0.001
% Women	36.4	37.4	38.1	41.5	40.0	<0.001
% University degree	54.0	43.8	34.9	27.1	17.9	<0.001
% Heavy occupational activity	6.4	5.8	6.6	8.3	10.5	<0.001
% Never smoked	53.5	51.6	48.1	41.6	36.1	<0.001

*Age-adjusted estimates.

Table 2 Adjusted hazard ratios (95% confidence limits) for incident diabetes among 23 855 participants according to the amount of time spent watching television each day (European Prospective Investigation into Cancer and Nutrition–Potsdam Study, 1994–2005)

	Television viewing (h/day)					*P* for linear trend
	<1	1–<2	2–<3	3–<4	4+	
Sample size	2715	7135	8078	3992	1935	–
No. events	55	209	293	239	131	–
Person-years of follow-up	21 389	56 417	63 296	30 703	14 550	–
Unadjusted rate per 1000 person-years	20.3	29.3	36.3	59.9	67.7	–
Model 1	1.00	1.23 (0.92, 1.66)	1.39 (1.04, 1.87)	1.97 (1.46, 2.66)	2.00 (1.43, 2.78)	<0.001
Model 2	1.00	1.23 (0.91, 1.65)	1.35 (1.01, 1.80)	1.86 (1.38, 2.52)	1.84 (1.32, 2.57)	<0.001
Model 3	1.00	1.19 (0.88, 1.60)	1.29 (0.97, 1.73)	1.78 (1.31, 2.40)	1.73 (1.24, 2.41)	<0.001
Model 4	1.00	1.22 (0.91, 1.65)	1.34 (1.00, 1.79)	1.84 (1.36, 2.48)	1.83 (1.31, 2.55)	<0.001
Model 5	1.00	1.21 (0.90, 1.63)	1.33 (0.99, 1.78)	1.82 (1.35, 2.47)	1.81 (1.30, 2.52)	<0.001
Model 6	1.00	1.13 (0.84, 1.52)	1.23 (0.92, 1.64)	1.65 (1.22, 2.23)	1.63 (1.17, 2.27)	<0.001
Model 7	1.00	1.11 (0.82, 1.50)	1.12 (0.84, 1.51)	1.38 (1.01, 1.88)	1.15 (0.81, 1.64)	0.108
Model 8	1.00	1.09 (0.80, 1.47)	1.10 (0.82, 1.48)	1.32 (0.97, 1.79)	1.13 (0.80, 1.60)	0.147
Model 9	1.00	1.09 (0.80, 1.47)	1.11 (0.82, 1.48)	1.32 (0.98, 1.79)	1.14 (0.81, 1.61)	0.138
Model 10	1.00	1.10 (0.82, 1.49)	1.12 (0.83, 1.50)	1.34 (0.99, 1.82)	1.17 (0.83, 1.65)	0.103
Model 11	1.00	1.10 (0.82, 1.49)	1.11 (0.83, 1.49)	1.35 (0.99, 1.82)	1.17 (0.83, 1.64)	0.111

Model 1 is adjusted for age, sex, educational status, and occupational activity.
Model 2 is adjusted for variables in Model 1 plus smoking status, alcohol use, and physical activity.
Model 3 is adjusted for variables in Model 2 plus dietary variables (meat, whole-grain bread, fruits and vegetables, coffee, soda, pizza, dessert, cake, chips, and total energy intake).
Model 4 is adjusted for variables in Model 2 plus dietary variables (intake of carbohydrates, protein, and total fat).
Model 5 is adjusted for variables in Model 2 plus dietary variables (intake of total fat, saturated fat, and total energy intake).
Model 6 is adjusted for variables in Model 3 plus systolic blood pressure (SBP).
Model 7 is adjusted for variables in Model 6 plus body mass index (BMI).
Model 8 is adjusted for variables in Model 6 plus waist circumference.
Model 9 is adjusted for variables in Model 6 plus waist circumference and BMI.
Model 10 is adjusted for variables in Model 4 plus SBP, waist circumference, and BMI.
Model 11 is adjusted for variables in Model 5 plus SBP, waist circumference, and BMI.

In proportional hazards analyses adjusted for sociodemographic variables, the HR for participants who watched ≥4 h/day television was 2.00 (95% CI: 1.43–2.78) compared with participants who watched < 1 h/day television (Table 2). Adjusting for behavioral variables, such as smoking, alcohol use, and physical activity, reduced the HRs a bit. Additional adjustment for macronutrients or various foods resulted in additional small reductions in the HRs. However, when the model was adjusted for waist circumference and BMI, the HRs were attenuated to the point being non-significant.

Discussion

In the present study, the amount of time spent watching television was a significant predictor of incident diabetes in analyses that adjusted only for sociodemographic factors and other lifestyle behaviors, including physical activity. The attenuation of the HR after adjustment for measured anthropometric variables is consistent with a mechanism by which excessive television viewing increases obesity, which, in turn, increases the risk for diabetes.

There are several limitations to the present study. First, undiagnosed diabetes was not identified. However, our estimates of relative risk should be accurate assuming that the association between the amount of time spent watching television and incident diabetes was similar in those with diagnosed and undiagnosed diabetes. Second, the amount of time spent watching television was self-reported and, thus, may be subject to recall bias. Third, despite adjusting the results for a substantial number of potential confounders, we may not have included all relevant confounders. For example, information concerning each participant's family history of diabetes was not available. In addition, the results may be subject to residual confounding.

Adults in many countries spend a substantial amount of time watching television.[8,9] There are several negative implications on health associated with watching an excessive amount of television. First, watching television represents a potential lost opportunity to engage in activities that increase energy expenditure. Second, energy expenditure while watching television is lower than that for other sedentary activities.[10] Third, the reduction in energy expenditure may be compounded by increases in energy intake attributable to exposure to television commercials that may spur additional eating, which increases energy intake and possibly also the intake of foods of questionable nutritional value.[11] Thus, reductions in the amount of time that people watch television could yield substantial public health benefits. In pediatric populations, interventions that reduce the amount of time spent watching television have demonstrated a favorable effect on obesity.[12]

Prudence dictates that people should limit the amount of time they spend watching television and dedicate at least some of this time to the pursuit of activities that increase energy expenditure. To this end, clinicians can inquire about the television viewing habits of their patients, counsel them about the negative impact excess television viewing can have on their health, and suggest healthier alternatives. As part of comprehensive public health efforts to promote physical activity in the population, interventions that motivate people to decrease their pursuit of sedentary activities, such as television viewing, deserve consideration.

Acknowledgments

The recruitment phase of the EPIC–Potsdam Study was supported by the Federal Ministry of Science, Germany (01 EA 9401) and the European Union (SOC 95201408 05F02). The follow-up of the EPIC–Potsdam Study was supported by the German Cancer Aid (70–2488-Ha I) and the European Community (SOC 98200769 05F02). The study was also supported by a grant from the German Research Foundation (DFG, KFO 114).

References

1. Hu FB, Leitzmann MF, Stampfer MJ, Colditz GA, Willett WC, Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. *Arch Intern Med*. 2001; **161**: 1542–8.
2. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003; **289**: 1785–91.
3. Tucker LA, Friedman GM. Television viewing and obesity in adult males. *Am J Public Health*. 1989; **79**: 516–18.
4. Ching PL, Willett WC, Rimm EB, Colditz GA, Gortmaker SL, Stampfer MJ. Activity level and risk of overweight in male health professionals. *Am J Public Health*. 1996; **86**: 25–30.
5. Boeing H, Wahrendorf J, Becker N. EPIC–Germany: a source for studies into diet and risk of chronic diseases. European Investigation into Cancer and Nutrition. *Ann Nutr Metab*. 1999; **43**: 195–204.
6. Bohlscheid-Thomas S, Hoting I, Boeing H, Wahrendorf J. Reproducibility and relative validity of energy and macronutrient intake of a food frequency questionnaire developed for the German part of the EPIC project. European Prospective Investigation into Cancer and Nutrition. *Int J Epidemiol*. 1997; **26** (Suppl. 1): S71–81.
7. Bohlscheid-Thomas S, Hoting I, Boeing H, Wahrendorf J. Reproducibility and relative validity of food group intake in a food frequency questionnaire developed for the German part of the EPIC project. European Prospective Investigation into Cancer and Nutrition. *Int J Epidemiol*. 1997; **26** (Suppl. 1): S59–70.
8. Nielsen Media Research. *Nielsen Media Research Reports Television's Popularity Is Still Growing*. Available from: http://www.nielsenmedia.com/nc/portal/site/Public/menuitem.55dc65b4a7d5adff3f65936147a062a0/?vgnextoid = 4156527aacccd010VgnVCM100000ac0a260aRCRD (accessed 14 May 2009).
9. Vioque J, Torres A, Quiles J. Time spent watching television, sleep duration and obesity in adults living in Valencia, Spain. *Int J Obes Relat Metab Disord*. 2000; **24**: 1683–8.
10. Ainsworth BE, Haskell WL, Leon AS et al. Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Exerc*. 1993; **25**: 71–80.
11. Gore SA, Foster JA, DiLillo VG, Kirk K, Smith West D. Television viewing and snacking. *Eat Behav*. 2003; **4**: 399–405.
12. Epstein LH, Valoski AM, Vara LS et al. Effects of decreasing sedentary behavior and increasing activity on weight change in obese children. *Health Psychol*. 1995; **14**: 109–15.