Strong Association Between Time Watching Television and Blood Glucose Control in Children and Adolescents With Type 1 Diabetes

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OBJECTIVE — To examine the relationship between blood glucose control and the time spent watching television in Norwegian children and adolescents with type 1 diabetes in a population-based study.

RESEARCH DESIGN AND METHODS — A total of 538 children and adolescents from 9 hospitals in the eastern part of Norway participated in the study; 70% of eligible subjects participated. The time spent watching television and time using a computer was recorded separately by interview together with clinical data. Mean (±SD) age was 13.1 ± 3.7 years, mean diabetes duration was 5.4 ± 3.4 years, and mean A1C was 8.6 ± 1.3% (reference range 4.1–6.4).

RESULTS — Sixty-two patients (11%) watched television <1 h daily (mean A1C 8.2 ± 0.9%), 189 patients (35%) watched television between 1 and 2 h daily (8.4 ± 1.2%), 166 patients (31%) watched television 2–3 h daily (8.7 ± 1.4%), 75 patients (14%) watched television 3–4 h daily (8.8 ± 1.2%), and 46 patients (9%) watched television ≥4 h daily (9.5 ± 1.6%). This trend was highly significant ($P < 0.001$). The association between television viewing and A1C remained significant, even after adjusting for age and BMI and insulin dose. No correlation between A1C and the use of a personal computer was observed.

CONCLUSIONS — Extensive television watching is associated with poor blood glucose control in children and adolescents with type 1 diabetes.

Diabetes Care 30:1567–1570, 2007

Sedentary behavior is associated with increased risk of obesity and cardiovascular disease (CVD) risk factors (1–3), and physical inactivity and lack of physical fitness are directly associated with increased mortality from CVD (4,5). One of the most common leisure time sedentary behaviors, television viewing, has been studied extensively in nondiabetic subjects (6–13). Findings suggest that this behavior has an effect on obesity and CVD risk factors that is independent of leisure time physical activity (1,3,7,14). These studies emphasize the relevance of studying sedentary behavior as a distinct entity.

Children and adolescents in the U.S. spend more time watching television than any other activity except sleep, and the time spent watching television may even exceed time spent in school (6,9,13,15). The vast majority of children in the U.S. are growing up in homes where television is a near-constant presence (16,17). The situation is similar in Norway, with at least one television set in almost every home in the country and 34% of all children having a television in their bedroom (18).

Patients with type 1 diabetes are at higher risk of developing CVD than the general population (19), and long-term blood glucose control is a strong predictor for CVD in type 1 diabetes (20–22). The development of atherosclerosis starts early in life (19). To our knowledge, no studies have reported the influence of television watching on blood glucose control or CVD risk factors in children and adolescents with type 1 diabetes.

RESEARCH DESIGN AND METHODS

The study was approved by the Governmental Regional Committee for Ethics in Medical Research and the Norwegian Data Inspection Board. The subjects gave written informed consent.

The study was performed in 2001 in eight pediatric departments in Norway. The clinics are located in the middle and east part of Norway, covering one large city (Oslo), smaller cities and towns, and countryside areas. All diabetic children in Norway are treated at the pediatric clinics of the public hospitals. A total of 70% of eligible subjects participated (hospital range 46–100%), with all but one clinic reporting >60% of their patients.

Data were collected from a case record form based on the World Health Organization Basic Information Sheet for children and adolescents. The case record form includes detailed information about the insulin regimen, acute and chronic complications, age, height, weight, puberty stages, blood pressure, and tobacco smoking. It also includes in-depth family history of diabetes and CVD. Daily time spent watching television or using a computer (including time spent playing computer games) was recorded separately by interview of the patient and, in the younger children, by interview of one or both of the parents. Subjects were asked for the number of hours spent watching television and video/DVDs for both week-

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Received for publication 12 October 2006 and accepted in revised form 9 March 2007.

Published ahead of print at http://care.diabetesjournals.org on 19 March 2007. DOI: 10.2337/dc06-2112.

Abbreviations: CVD, cardiovascular disease.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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Table 1—*Patient characteristics*

	Male subjects	Female subjects	Total
n	265	273	538
Age (years)	13.1 ± 3.5	13.0 ± 3.9	13.1 ± 3.7
Duration of disease (years)	5.4 ± 3.1	5.7 ± 3.5	5.6 ± 3.4
A1C (%)	8.6 ± 1.3	8.7 ± 1.3	8.6 ± 1.3
BMI (kg/m²)	19.3 ± 3.1	20.3 ± 3.1	19.8 ± 3.1

Data are means ± SD.

days and weekend days. The average number of hours watching television per day was used for data analysis. All patients were interviewed and examined at the outpatient clinic they attended. The responsible physician performed an extended and standardized examination of all patients. A1C was measured in the same central laboratory for all patients by high-performance liquid chromatography (Variant; Bio-Rad, Richmond, CA), Diabetes Control and Complications Trial standardized. The intra-assay coefficient of variation was <3%. Reference values were 4.1–6.4%.

Statistical analysis. All statistical analyses were done using the SPSS software package for Windows, version 14.0 (SPSS, Chicago, IL). Data are presented by means ± SD or proportions. The BMI values were standardized by conversion to *z* score in groups defined by age and sex, using the Centers for Disease Control and Prevention growth charts 2000 (23). This calculation was done using EpiInfo 2005 version 3.3.2 (Centers for Disease Control, Atlanta, GA). Spearman's correlation coefficient was used to analyze the association between two continuous variables. Differences in continuous variables between male and female subjects were tested with a Mann-Whitney test. Unadjusted linear regression was used to analyze the association between television viewing and independent variables of interest. Further multiple regression analysis was used to determine whether the association between television viewing and A1C remained significant after adjusting for other independent variables. A significance level of 5% was used.

RESULTS — The number of patients included in the study was 538. The mean age of the patients was 13.1 ± 3.7 years, diabetes duration was 5.4 years, and the mean A1C was 8.6 ± 1.3% (Table 1). They watched television for 1.9 h per day (range 0–8) (114 min per day) on average. There were no differences between male and female subjects with regard to age, diabetes duration, A1C, and hours of watching television. The distribution of the number of hours of television viewing per day is shown in Table 2. A total of 62 patients (11%) watched television <1 h daily (mean A1C 8.2 ± 0.9%). A total of 189 patients (35%) watched television between 1 and 2 h daily (mean A1C 8.4 ± 1.2%). A total of 166 patients (31%) watched television 2–3 h daily (mean A1C 8.7 ± 1.5%). A total of 75 patients (14%) watched television 3–4 h daily (mean A1C 8.8 ± 1.2%). A total of 46 patients (9%) watched television ≥4 h daily (mean A1C 9.5 ± 1.6%). Figure 1 shows the relationship between viewing hour and A1C. There was a continuous increase in A1C with every hour of watching television, and the test for trend was highly significant ($P < 0.001$) (Table 2). No association between A1C and the use of a personal computer was found (data not shown).

A statistically significant positive association between television viewing and age and insulin dose (IE/kg) was demonstrated but not with BMI *z* score (see Table 2). Multiple regression analysis showed a strong association between television viewing and A1C even after adjusting for age and BMI and insulin dose (Table 3).

CONCLUSIONS — In the present population-based study of 538 children and adolescents with type 1 diabetes, we show for the first time a continuous increase in A1C with every hour of watching television. This association was independent of age, duration of disease, and BMI. The American Academy of Pediatrics recommends that children's television viewing should be limited to no more than 2 h per day (15). Fifty-five percent of the patients in our study exceeded this limit.

Several modes of behavior might explain the positive association between television viewing and A1C. Television viewing might displace physical activity and encourage poor dietary habits. However, physical activity and television viewing are poorly related in other studies in the general population (11,12,24). Furthermore, physical activity is not necessarily associated with good metabolic control in type 1 diabetic patients (25–27). Therefore, our results can probably not be explained as a result of little physical activity alone. However, even though physical activity does not seem to influence A1C in other studies, sedentary behavior like television watching might do so. Energy expenditure during television viewing seems to be lower than during any other sedentary activities (28) and even below resting level (29). Television viewing also has been found to be associated with snacking behavior, and participants who spend more time watching television tend to follow an unhealthy eat-

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Table 2—*A1C, age, and BMI and insulin dose related to hours of watching television*

Television viewing	*n* (%)	A1C (%)	Age (years)	BMI (kg/m²)	BMI *z* score	Insulin dose (units · kg^{-1} · day^{-1})
<1 h	62 (11.5)	8.19 ± 0.9	12.76 ± 4.1	19.28 ± 3.4	0.14 ± 0.9	0.90 ± 0.3
1–2 h	189 (35.1)	8.39 ± 1.2	12.20 ± 3.9	19.32 ± 3.2	0.28 ± 0.9	0.91 ± 0.3
2–3 h	166 (30.9)	8.67 ± 1.5	13.40 ± 3.4	20.05 ± 3.6	0.22 ± 1.0	0.99 ± 0.4
3–4 h	75 (13.9)	8.80 ± 1.2	13.68 ± 2.9	20.34 ± 3.5	0.23 ± 1.0	1.12 ± 0.4
≥4 h	46 (8.6)	9.48 ± 1.6	14.61 ± 3.4	21.84 ± 3.0	0.29 ± 0.8	0.98 ± 0.4
Trend analysis (*P* values)		<0.001	<0.001	<0.002	0.88	0.001

Data are means ± SD unless otherwise indicated.

Table 3—*TV viewing according to A1C, age, BMI z score and insulin dose*

Variable	Crude estimate (95% CI)	*P* value	Adjusted (95% CI)*	*P* value
A1C (%)	0.22 (0.15–0.30)	<0.001	0.19 (0.10–0.27)	<0.001
Age (years)	0.06 (0.03–0.09)	<0.001	0.05 (0.01–0.08)	0.01
BMI *z* score	0.01 (−0.10 to 0.12)	0.88	−0.006 (−0.12 to 0.11)	0.91
Insulin dose (units · kg^{-1} · day^{-1})	0.47 (0.18–0.76)	0.001	0.13 (−0.19 to 0.44)	0.42

*Adjusted for all other variables in the table with multiple regression analysis.

ing pattern (30,31). The combination of those factors, less physical activity, increased sedentary behavior, less energy expenditure, and increased food and energy intake could, at least in part, explain our finding.

A significant association between excessive television viewing and obesity has been found (6,8,10,11). In addition, several studies have reported that this association is independent of physical activity and fitness level (7,9,11,24) and highly specific for television viewing. Other sedentary leisure activities did not show any significant association with obesity (24,29). However, we found no association between television viewing and BMI *z* score in our study, and the regression analysis showed that the association between television viewing and A1C was independent of BMI.

Several other factors might influence the observed relationship between television viewing and A1C. Such factors include socioeconomic status and psychosocial factors, such as family structure and function, parenting style, and depressive symptoms. Individuals who generally cannot cope very well with life and those living in poorly functioning families might have problems with meeting the challenges of type 1 diabetes, and the high level of A1C is simply an indicator of this. These individuals might be inclined to watch more television. Environmental factors, particularly parental behaviors, have been considered to be important influences on adolescent television habits, as adolescents of heavy television–viewing parents report spending more time watching television (32,33). Lower socioeconomic status and parental education and living in a single-parent home also has been reported to be associated with higher television viewing time (34–36). Furthermore, elevated depressive symptoms is associated with a higher level of television viewing in adolescents as well as adults (2,36,37).

A limitation of this study is that we did not register physical activity, eating habits, or other leisure activities apart from television viewing, nor do we have any information about the socioeconomic or psychological status of our patients. Additional work is required to elucidate the potential behavioral and psychological mechanisms for the observed associations. However, a potential implication of this study is to ask about the time spent watching television and other leisure activities, especially if the metabolic control of the children is poor.

Improvement in long-term blood glucose control is important because it is a strong predictor of early coronary atherosclerosis (20) and CVD events (21). Our findings lend support to the American Academy of Pediatrics' recommendation and suggest that encouraging children with type 1 diabetes to watch less television may be important for improved blood glucose control and better health outcomes.

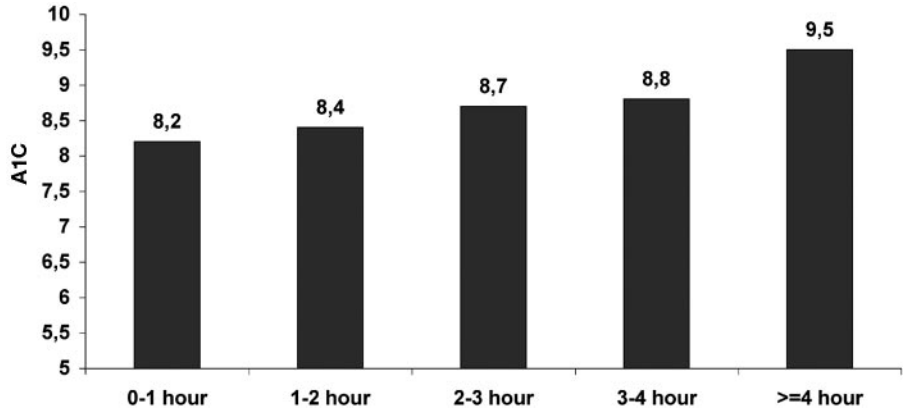

Figure 1—*Relationship between hours of watching television and A1C.*

Acknowledgments— The authors thank the following members of the Norwegian Study Group of Childhood Diabetes who participated in data collection in this study: Halvor Bævre, Ola Talleraas, Sigurd Børsting, Helge Vogt, Hans Jakob Bangstad, Hilde Bjørndalen, Kjell Stensvold, Bjørn Halvorsen, and Kristin Hodnekvamm. Knut Lande and Kari Oppsiøn were responsible for centralized A1C analysis. Siv Janne Kummrnes and Beth Tyrdal were responsible for study coordinating functioning.

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