

# Social factors and television use during meals and snacks is associated with higher BMI among pre-school children

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## Abstract

*Aim:* The present paper examines the relationship between social factors, food consumption during television viewing, and overall television viewing and how these are associated with BMI when the role of familial and social factors are considered in a population-based birth cohort of pre-school children from Québec (Canada).

*Methods:* The analyses were performed using data from the Longitudinal Study of Child Development in Québec (1998–2002) (LSCDQ). The study follows a representative sample ( $n$  2103) of children born in 1998 in the Canadian province of Québec. A nutrition assessment was conducted on 1549 children aged 4–5 years and included a 24 h dietary recall, an eating behaviour and television viewing questionnaire, and a measurement of children's heights and weights. Statistical analyses were performed.

*Results:* Nearly one-quarter of children ate at least twice daily in front of the television. Children who consumed snacks while watching television on a daily basis had higher BMI than children who did so less frequently. Children who ate snacks in front of the television every day, or some times during the week, ate more carbohydrates (total), more fat and less protein, fewer fruits and vegetables, and drank soft drinks more often than children who never ate snacks in front of the television.

*Conclusions:* Health professionals should target parents of children at risk of overweight/obesity with focused strategies to help children change the types of foods consumed during television viewing and to reduce the time spent watching television, particularly during meal times, which may change children's dietary intake and eating patterns.

**Keywords**  
Television viewing  
Nutrition  
Pre-school children  
Obesity  
Social factors

Overweight among children has increased dramatically over the past two decades and is approaching epidemic proportions<sup>(1–3)</sup>. It is well known that behavioural, environmental, genetic and social factors may influence a child's propensity for becoming overweight<sup>(1,2)</sup>. However, recent lifestyle trends have led to the development of 'obesogenic' environments<sup>(3–6)</sup>, and it is not clear which factors are the most important contributors to this risk among young children. While childhood obesity has been linked to television viewing<sup>(7–10)</sup>, specific mechanisms are not well understood. Decreased physical activity, an increased sedentary lifestyle, increased food intake and decreases in metabolic rate, or a combination of these factors, have been implicated.

Coinciding with increases in childhood overweight is an increase in sedentary behaviours such as television viewing, playing video games and computer use<sup>(9)</sup>. Paediatric guidelines for healthy living recommend that children should not watch television for more than 2 h per

day, yet North American children watch an average of 2 h or more daily<sup>(9,11)</sup>. It has been reported that children who watch television for 2 h or more daily are twice as likely to be overweight as children who spend 1 h or less in front of the screen daily<sup>(9)</sup>. In fact, the amount of television watched during early childhood is associated with higher BMI in adulthood<sup>(12–14)</sup>. Although it is thought that television viewing displaces more vigorous activity, the evidence to support this remains inconclusive. For example, while one study of 5-year-old Australian children reported that computer use was related to other sedentary activity such as television viewing and less vigorous activity<sup>(15)</sup>, another study failed to support the notion that television interferes with time spent in active play<sup>(16)</sup>.

Evidence for supporting an association between television viewing and overweight among children is moderately strong. Longitudinal studies of pre-school children<sup>(7,8,13,17,18)</sup> and national cross-sectional surveys (e.g. Third National Health and Nutrition Examination Survey, 1994 National

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Longitudinal Survey of Children and Youth) have found positive associations with television viewing and overweight among children<sup>(10,19–21)</sup>. One intervention study reported decreases in BMI for those who reduced television viewing compared with controls<sup>(22)</sup>. Conversely, other studies found an inconsistent or weak association between television viewing and BMI<sup>(23,24)</sup>. A recent meta-analysis reported that the correlation between television viewing and BMI was weak and clinically unimportant<sup>(25)</sup>, while others claim that although the effect of television viewing on body weight is small, it remains an important factor contributing to childhood obesity<sup>(26)</sup>. Given that few studies have examined whether food consumption during television viewing is related to body weight in pre-school children, elucidation of this issue will contribute to an important field of study that has not been widely investigated.

The present paper examines the relationship between social factors, food consumption during television viewing and overall television viewing, and how these relate to BMI, in a population-based birth cohort of pre-school children from Québec (Canada).

## Methods

### *Sample selection*

The analyses were performed using 2002 data from the Longitudinal Study of Child Development in Québec (1998–2002) (LSCDQ), conducted by Santé Québec, a division of the Institut de la Statistique du Québec in Canada<sup>(27,28)</sup>. Ethical approval from the Ministry of Health Ethics Committee (Comité d'Éthique de Santé Québec) and consent from participants were obtained. The LSCDQ examines the role of familial and social factors on children's health and on cognitive and behavioural development. It follows a representative sample ( $n$  2103) of children born in 1998 in the province of Québec (total population over 7 million, with approximately 70 000 newborns per year). The representative sample was chosen by a random selection of children born throughout the year in each public health geographic area of the province, thereby minimizing the seasonality effect and ensuring geographic representation. Twins and children with major diseases or handicaps at birth were not included.

### *Data collection*

The children were first seen at 5 months (gestational age adjusted for preterm birth) and subsequently at 1-year intervals. At each data collection point, structured face-to-face interviews using standardized questionnaires were conducted with the caregiver deemed most knowledgeable of the child, generally the mother. Of the 2103 infants at baseline, 1944 remained at 4–5 years in 2002. The children's age varied from 44 to 56 months with a mean of 49 (SD 3.12) months. A representative sample of 1549

children volunteered to take part in the nutrition study. The nutrition assessment included: a 24 h dietary recall interview when the children were 4.5 years old; a self-administered eating behaviour and television viewing questionnaire (when the children were 2.5, 3.5 and 4.5 years old); and measurement of children's height and weight in 2002, when the children were 4.5 years old.

Children's height and weight were measured at least twice at home by a trained nutritionist following a standardized protocol using a measuring tape, ruler and scale when children were 4.5 years old<sup>(29)</sup>. The children were weighed without shoes and wore light clothing. Children's weights were analysed using BMI (weight (kg)/[height (m)]<sup>2</sup>). Overweight was defined as having a BMI at or above the 95th percentile on the US Centers for Disease Control and Prevention sex- and age-specific growth charts<sup>(30)</sup>.

### *Degree of physical activity measure*

The degree of children's physical activity was measured through one survey question that asked mothers: 'In your opinion, is your child's level of physical activity less than or more than children of the same age and same sex?' Mothers were asked to choose one of the following categories: 'much higher', 'slightly higher', 'equal', 'slightly less', 'much less than', 'do not know' and 'refused'. Responses that involved 'don't know' and 'refused' were coded as missing values.

### *Eating behaviour and television viewing self-administered questionnaire*

Mothers were asked to indicate, for each meal (e.g. breakfast, lunch, dinner) and snacks, how often their child eats while watching television. Responses included: 'every day', 'some times weekly', 'less than once weekly' or 'never'. The mother's responses were combined by assigning a score proportional to a daily frequency, varying from 0 to 1 (never = 0 and every day = 1), to each response and then summed together to construct an overall Eat-while-TV-watching index. The resulting index ranged from 0 to 4 indicating the frequency of eating while watching television on a daily basis. Mothers were also asked to indicate the child's total number of hours of television viewing per day, during the week and then during the weekend. The total number of hours was added and the child was then categorized as watching television for a mean of '3 h or more daily' or 'less than 3 h daily'.

### *Energy/macronutrient intake and food consumption analysis*

Energy and macronutrient intake, food consumption levels and meal patterns were derived from a single 24 h recall interview administered in the home by trained nutritionists<sup>(29)</sup>. Mothers were asked to indicate the foods (e.g. type, quantity, recipes) eaten during the 24 h period preceding the interview. All foods and beverages

consumed by the child within the previous 24 h were recorded by the nutritionist. Volume food models were used to determine food portion sizes and food labels were verified for nutrition information. A second 24 h recall administered to half ( $n$  696) of the sample allowed for the adjustment of recall data for random intra-child variability and to ensure representativeness of usual food consumption patterns<sup>(31)</sup>. All analyses were conducted using adjusted data and the results based on usual food consumption patterns<sup>(29)</sup>.

The 24 h recall questionnaires were administered evenly across all days in the week. Energy and macro-nutrient consumption, along with servings of food for each meal and for each child, were evaluated according to the Canadian Nutrient File<sup>(32)</sup> and the US Department of Agriculture recipe file<sup>(33)</sup>, which calculates usual consumption of foods in accordance with Canada's Food Guide to Healthy Eating: vegetables and fruits, grain products, milk products, and meat and alternatives<sup>(34)</sup>. These data were managed using a validated nutrient analysis software by Micro Gesta (version 73, Québec, Canada), developed specifically for Canadian nutritional studies. Final consumption and serving estimates were adjusted to minimize within-child variability<sup>(29)</sup>. More details pertaining to the study instruments and methodology can be found on the LSCDQ website (<http://www.jesuisjeserai.stat.gouv.qc.ca>).

### Statistical analysis

The data were weighted by a factor based on the inverse of the selection probability, the probability of non-response, and the post-stratification and attrition rates to ensure that all information collected was longitudinally representative of infants born in 1998 in the population<sup>(35)</sup>. Preliminary analyses indicated that the 1549 children participating in the nutrition study were representative of the same-aged children in the population. Statistical analyses were based on individuals with no missing values for any of the studied variables. Of the 1549 infants, 1540 (99% of the sample) were part of the analyses. The impact of missing data was analysed by conducting with-and-without analyses. Missing data were excluded from the analyses since they had no impact on the results.

The selection of covariates for the study was determined based on the literature for children's eating and television viewing behaviours and overweight status, on their availability in the study and on their statistical association with the dependent variables under study. The main and covariate variables used in the study, along with a description of the variable categories and their distribution across the study population, are presented in Table 1. These variables include: characteristics of the mother, such as age, immigrant status, education, working status in the last 12 months and self-perceived health status; mother and father's smoking status and the derived number of smoking parents in the household; family

type, household annual income and socio-economic status\* (based on mother's and father's education and work prestige along with income level); and other variables pertaining to the child including day-care attendance and sex of the child.

Statistical analyses were conducted using the Statistical Analysis Systems statistical software package version 8.2 (SAS Institute, Cary, NC, USA). Associations between independent variables and dependent variables were verified through  $\chi^2$  tests on contingency tables. Significant independent variables were included in the multivariate analyses. Adjusted odds ratio estimates, as well as their confidence intervals, were computed using logistic regression analysis. Adjusted means were calculated by one-way ANOVA and *post hoc* testing was performed only when the overall *F* test was significant. The analyses used weighted data and the significance level was set at 5%.

For each multivariate analysis, the relationship between each independent and the dependent variable was first assessed by means of a bivariate analysis, one at a time; significant variables were then retained for the multivariate analysis, even if they no longer remained significant in the multivariate model. All variables found to be significantly associated at the bivariate level remained significant in the multivariate model. Furthermore, interactions between all variables were examined and assumptions were verified. Continuous variables were analysed using one-way ANOVA. Whenever the overall *F* test was significant, a pairwise comparison of the categories of the independent variable was conducted using Tukey's test.

### Results

Figure 1 presents the proportion of children who ate while watching television across different meals and snacks. More than one-fifth (21.7%) of 4.5-year-old children ate breakfast while watching television, 7.3% did so while eating lunch and 12.3% did so while eating dinner.

Table 1 shows the association of several child, parental and family characteristics with the practice of watching television during the daily consumption of breakfast, lunch, dinner and snacks. It can be seen that maternal age was significantly associated with the every day practice of eating lunch while watching television. When comparing children with mothers aged 25–34 years, a greater proportion of children from younger mothers and, to a lesser extent, children from older mothers ate lunch while watching television. Having an immigrant mother, as opposed to a non-immigrant mother, was also significantly associated with a child eating breakfast and

\* The socio-economic indicator combines measures describing occupational prestige, educational level and financial situations of parents based on the method developed by Willms and Shields<sup>(36)</sup>.



**Fig. 1** Proportion of children eating while watching television (■, every day; ■, some times weekly; ■, less than once weekly; □, never) meals and snacks: 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002). \* $P < 0.0001$

snacks in front of the television every day. A lower level of maternal education was also significantly associated with a greater proportion of children eating in front of the television for every meal and snack, with main differences being seen between children from mothers holding a high school diploma or less and children from mothers who achieved more than a high school diploma. A greater proportion of children from non-working mothers and children who did not attend day care also ate lunch and snacks every day in front of the television. A greater proportion of children from mothers who reported not being in excellent or very good health, and children who had smoking mothers and fathers, also ate meals and

**Table 1** Proportion (%) of children eating breakfast, lunch, dinner or snacks while watching television every day, by child, parental and family characteristics: 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002)

Characteristic	Category	%	Eating every day while watching television			
			Breakfast	Lunch	Dinner	Snacks
Total			21.7	7.3	12.3	17.0
Child's sex	(0) Girl	48.7	20.2	6.0	10.2	16.1
	(1) Boy	51.3	23.2	8.4	14.3	17.9
Mother's age group	(1) Less than 25 years	6.9	30.0	12.1*	17.3	24.2
	(2) 25–29 years	23.2	20.7	5.1	11.5	20.3
	(3) 30–34 years	32.0	17.9	4.9	9.6	13.1
	(4) 35 years or more	37.9	23.9	9.6	14.3	16.8
Mother's immigrant status†	(0) Not immigrant	86.3	20.7*	7.4	11.5	15.7*
	(1) Immigrant	13.7	27.8	6.6	17.5	24.9
Mother's education	(1) No high school diploma	15.9	28.0*	12.7*	21.3*	30.9*
	(2) High school diploma	22.5	28.0	12.2	13.8	24.2
	(3) College diploma	34.7	19.7	5.6	11.6	13.4
	(4) University diploma	27.0	15.1	2.1	6.9	7.3
Mother's working status (last 12 months)	(0) Did not work	27.3	22.9	10.3*	13.4	25.5*
	(1) Worked part-time	20.0	23.6	7.1	13.4	13.6
	(2) Worked full-time	52.7	20.3	5.7	11.4	13.8
Mother's health status	(0) Excellent/Very good	70.9	20.4	5.8*	9.4*	14.7*
	(1) Good/Average/Poor	29.1	24.7	10.8	19.5	22.5
Mother's smoking status	(0) Non/occasional smoker	74.7	19.4	5.5*	10.3*	14.5*
	(1) Regular smoker	25.3	25.2	11.2	17.1	23.2
Father's smoking status	(0) Non/occasional smoker	72.1	18.4*	5.7*	10.4*	14.1*
	(1) Regular smoker	27.9	27.4	10.3	16.1	25.1
Number of smoking parents	(0) 0	68.6	19.7*	5.9*	11.1	14.5*
	(1) 1	20.6	22.5	6.9	13.0	17.1
	(2) 2	10.8	31.8	15.4	18.1	30.9
Single-parenting	(0) No	85.2	20.8	7.0	12.1	16.7
	(1) Yes	14.8	27.5	9.1	13.7	19.1
Household annual income	(1) <20 000\$	10.5	27.7*	11.0*	12.6	28.4*
	(2) 20 000–39 999\$	20.9	26.9	10.8	17.6	27.3
	(3) 40 000–59 999\$	26.2	20.8	8.5	15.7	15.8
	(4) ≥60 000\$	42.5	18.3	3.8	7.5	9.9
Socio-economic status‡	(1) Quintile 1 (Low)	20.0	28.3*	13.2*	19.8*	32.0*
	(2) Quintile 2	20.0	22.9	8.1	11.9	18.5
	(3) Quintile 3	20.5	18.6	7.6	14.9	18.1
	(4) Quintile 4	20.1	19.9	4.5	9.4	9.6
	(5) Quintile 5 (High)	19.7	17.4	2.1	5.2	6.5
Day-care attendance	(1) Not in day care	30.5	20.7	10.4*	12.3	21.7*
	(2) At someone else home	35.3	22.1	7.3	12.1	15.0
	(3) In a day-care centre	34.2	22.2	4.5	12.4	14.5
Total daily television viewing	(0) Less than 3 h	78.3	19.1*	5.9*	10.8*	13.4*
	(1) 3 h or more	21.7	31.2	12.1	17.9	29.9

\*Statistically significant association between the characteristic and the dependent variable ( $\chi^2$  test): \* $P \leq 0.05$ .

†Mothers were classified as immigrant and non-immigrant according to whether they were Canadian-born (non-immigrant) or immigrated from Europe or from non-European countries (immigrant). Eighty-eight per cent of the mothers were Canadian-born (85%) or European (3%), while 12% were from non-European countries (Institut de la Statistique du Québec, 2003).

‡Socio-economic indicator combines measures describing occupational prestige, educational level and financial situations of parents based on the method developed by Wilms and Shields<sup>(36)</sup>.

snacks in front of the television every day compared with children from mothers who reported having excellent or very good health and children from non-smoking parents. A greater proportion of children who ate while watching television also came from families with low family income and low socio-economic status. Although the differences were not significant, there was a tendency to observe an association between single parenting and the daily practice of eating while television viewing. Finally, the total number of hours of television viewing was associated with eating meals and snacks while watching television, especially during breakfast and snacks, where almost one-third of children who ate while watching television watched television for 3 h or more daily.

Table 2 presents how various child and parental characteristics associate with frequency of eating in front of the television and total hours spent watching television every day. Overall, about one-third (32%) of children watched television while eating once daily, while one-quarter (25%) did so at least twice daily. A greater proportion of girls ate while watching television less than once daily, whereas a greater proportion of boys ate while watching television once daily. The daily frequency of eating during television viewing decreased as maternal age and maternal level of education increased. A greater proportion of children who ate while watching television at least twice daily also had mothers who perceived themselves as having 'bad health', parents who smoked, and families with lower family income and lower socio-economic status. Maternal work, day-care attendance and single parenting were not associated to the daily frequency of eating during television viewing. A higher frequency of eating while watching television was also associated with children watching television for a total of 3 h or more daily. Watching television for a total of 3 h or more daily was associated with children having immigrant mothers, mothers with a lower level of education, non-working mothers, children not attending day care, mothers who perceived themselves as 'not being in excellent or very good health', parental smoking, lower family income and lower socio-economic status.

Table 3 presents the adjusted means of energy and macronutrient consumption (total and percentage of energy) by frequency of eating during television viewing. Energy consumption was not associated with eating during television viewing. Children who ate snacks while watching television every day or some times during the week consumed more carbohydrates (total grams) and less energy from proteins compared with children who never ate snacks in front of the television. Eating during television viewing once daily or more was also associated with lower consumption energy derived from proteins. The adjusted mean consumption of fat (both total and by percentage of energy) was also higher for children who watched television for a total of 3 h or more daily in comparison to children who watched for less than 3 h

daily; however, the consumption of fat was not associated with eating during television viewing.

In terms of food group servings (Table 4), adjusted data analyses indicate that fruit and vegetable consumption was associated with eating during television viewing. Eating dinner or snacks every day while watching television was associated with consumption of fewer servings of fruits and vegetables. A higher frequency of eating while watching television (three or four times daily) and of total television viewing per day (3 h or more daily) was also associated with a lower daily consumption of fruits and vegetables.

Eating breakfast, lunch and dinner while watching television increased the odds of drinking soft drinks every day (data not shown), but eating snacks while watching television had the greatest effect on daily soft drink consumption. Figure 2 presents the adjusted odds ratios for drinking soft drinks every day by frequency of eating snacks while watching television and by frequency of total eating patterns during television viewing. In comparison with children who never ate during television viewing, the odds of drinking soft drinks every day more than doubled for children who ate snacks while watching television some times weekly (OR = 2.3; 95% CI 1.5, 3.6) and more than tripled for children who ate snacks while watching television every day (OR = 3.6; 95% CI 2.2, 5.7). As total daily frequency of eating while television viewing increased, the odds of drinking soft drinks every day also increased. In comparison with children who ate in front of the television less than once daily, children who ate in front of the television once or twice daily had, respectively, 70% (95% CI 1.2, 2.4) and 83% (95% CI 1.2, 2.7) increased odds of drinking soft drinks every day. The odds more than doubled for those who ate in front of the television three or four times daily (OR = 2.3; 95% CI, 1.5, 3.6). Total hours of television viewing did not increase the odds of drinking soft drinks every day (data not shown).

Figure 3 presents the mean BMI of children according to television viewing and eating practices. Overall, there was no significant difference between the mean BMI of children who watched television for less than 3 h daily *v.* those who watched for 3 h or more daily. However, children who ate while watching television once daily or more had significantly higher mean BMI in comparison to children who ate while watching television less than once daily. More specifically, there was a significant difference between the mean BMI of children who ate snacks or dinner once daily or more in front of the television in comparison to children who did so less than once daily. This relationship was not apparent for children who ate breakfast or lunch in front of the television.

Figure 4 presents the adjusted mean BMI by energy consumption for different frequencies of eating snacks in front of the television. The figure indicates that there was no significant association between BMI and energy consumption for children who never ate snacks while



**Table 2** Proportion (%) of children eating during television viewing and total hours of television viewing, by child, parental and family characteristics: 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002)

Characteristic	Category	Frequency of eating and television viewing per day				Total number of hours of television viewing per day	
		Never or less than once	Once	Twice	Three or four times	Less than 3 h	3 h or more
Total		43.0	32.1	15.0	9.9	78.3	21.7
Child's sex	(0) Girl	46.9*	29.9*	14.1	9.1	80.3	19.7
	(1) Boy	39.4	34.3	15.8	10.6	76.4	23.6
Mother's age group	(1) Less than 25 years	35.5	22.9*	25.0*	16.6*	67.7	32.3
	(2) 25–29 years	41.3	33.7	16.4	8.7	77.5	22.5
	(3) 30–34 years	46.0	35.3	11.8	6.9	79.2	20.8
	(4) 35 years or more	42.8	30.7	14.9	11.7	79.7	20.3
Mother's immigrant status	(0) Not immigrant	44.0	32.7	13.9*	9.4	79.5*	20.5*
	(1) Immigrant	35.9	30.3	21.3	12.4	70.2	29.8
Mother's education	(1) No high school diploma	30.7*	26.7*	25.5*	17.1*	68.6*	31.4*
	(2) High school diploma	32.9	36.7	16.6	13.9	70.7	29.3
	(3) College diploma	45.1	33.3	13.7	7.9	80.3	19.7
	(4) University diploma	55.7	30.8	8.9	4.6	87.5	12.5
Mother's working status (last 12 months)	(0) Did not work	37.7	31.3	19.1	11.8	70.5*	29.5*
	(1) Worked part-time	43.4	31.8	15.2	9.7	79.1	20.9
	(2) Worked full-time	45.5	33.0	12.6	8.9	81.9	18.1
Mother's health status	(0) Excellent/Very good	45.9*	33.2	13.4*	7.5*	80.6*	19.4*
	(1) Good/Average/Poor	35.8	30.2	18.7	15.4	72.5	27.5
Mother's smoking status	(0) Non/occasional smoker	45.1*	33.4	13.5*	8.0*	80.2*	19.8*
	(1) Regular smoker	38.2	29.4	18.8	13.6	72.9	27.1
Father's smoking status	(0) Non/occasional smoker	46.2*	32.3	13.7*	7.8*	81.6*	18.4*
	(1) Regular smoker	38.4	27.4	19.3	14.9	72.6	27.4
Number of smoking parents	(0) 0	46.4*	32.1	12.7*	8.8*	81.4*	18.6*
	(1) 1	38.4	35.1	17.6	8.9	73.5	26.5
	(2) 2	31.5	26.5	24.1	17.9	68.3	31.7
Single-parenting	(0) No	43.5	31.9	14.9	9.7	79.0	21.0
	(1) Yes	39.2	34.0	15.6	11.2	74.0	26.0
Household annual income	(1) <20 000\$	34.2*	33.7	19.8*	12.3*	65.3*	34.7*
	(2) 20 000–39 999\$	35.4	27.8	19.5	17.3	73.1	26.9
	(3) 40 000–59 999\$	42.4	31.3	17.4	8.9	77.0	23.0
	(4) ≥60 000\$	49.4	34.3	10.2	6.2	84.8	15.2
Socio-economic status	(1) Quintile 1 (Low)	30.7*	30.6	21.1*	17.7*	67.4*	32.6*
	(2) Quintile 2	38.2	33.5	18.6	9.7	75.4	24.6
	(3) Quintile 3	40.5	34.3	15.6	9.6	80.4	19.6
	(4) Quintile 4	49.2	32.9	11.2	6.8	83.0	17.0
	(5) Quintile 5 (High)	57.1	30.0	8.6	4.4	87.4	12.6
Day-care attendance	(1) Not in day care	42.5	29.2	16.9	11.5	69.3*	30.7*
	(2) At someone else home	43.2	30.6	16.1	10.2	82.1	17.9
	(3) In a day-care centre	43.6	36.3	12.0	8.1	82.4	17.6
Total television viewing per day	(0) Less than 3 h	46.8*	31.8	13.6*	7.7*	–	–
	(1) 3 h or more	29.2	33.1	20.0	17.7	–	–

\*Statistically significant association between the characteristic and the dependent variable ( $\chi^2$  test): \* $P \leq 0.05$ .

**Table 3** Adjusted† means (standard error) of energy and macronutrient consumption by frequency of eating while watching television: 2002 data on 4·5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002)

Characteristic	Category	Energy (kJ)		Energy (kcal)		Carbohydrates (g)		Total fats (g)		Proteins (g)		Carbohydrates (% of energy)		Total fats (% of energy)		Proteins (% of energy)	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Total		6653	29	1589	7	215	1·0	55·7	0·30	58·5	0·3	53·8	0·09	31·4	0·06	14·5	0·04
Eating breakfast while watching television	(1) Every day	6674	130	1594	31	213	4·3	56·5	1·29	58·5	1·48	52·9	0·43	32·0	0·29	14·5	0·22
	(2) Some times weekly	6531	130	1560	31	209	4·3	55·4	1·29	57·6	1·47	52·9	0·42	31·9	0·29	14·6	0·22
	(3) Less than once weekly	6460	142	1543	34	207	4·7	54·8	1·40	57·8	1·60	52·9	0·46	31·9	0·32	14·8	0·24
	(4) Never	6536	126	1561	30	209	4·2	55·2	1·26	58·4	1·44	52·9	0·41	31·9	0·29	14·8	0·22
Eating lunch while watching television	(1) Every day	6716	159	1604	38	213	5·3	56·9	1·57	58·7	1·80	52·8	0·52	32·1	0·36	14·5	0·27
	(2) Some times weekly	6598	130	1576	31	210	4·4	56·3	1·31	57·8	1·49	52·9	0·43	32·0	0·30	14·5	0·23
	(3) Less than once weekly	6485	134	1549	32	210	4·5	54·0	1·34	56·9	1·53	53·4	0·44	31·6	0·31	14·6	0·23
	(4) Never	6552	126	1565	30	209	4·2	55·5	1·24	58·7	1·41	52·7	0·41	32·0	0·28	14·8	0·21
Eating dinner while watching television	(1) Every day	6665	138	1592	33	213	4·7	56·6	1·39	58·5	1·59	53·1	0·46	32·0	0·32	14·5	0·24
	(2) Some times weekly	6510	130	1555	31	209	4·3	54·8	1·28	57·3	1·47	53·1	0·42	31·8	0·29	14·6	0·22
	(3) Less than once weekly	6548	134	1564	32	209	4·5	55·6	1·34	58·5	1·53	52·8	0·44	31·9	0·30	14·8	0·23
	(4) Never	6561	126	1567	30	209	4·2	55·6	1·25	58·5	1·43	52·7	0·41	32·0	0·29	14·8	0·22
Eating snacks while watching television	(1) Every day	6649	130	1588	31	213*	4·3	56·1	1·29	57·5	1·48	53·2	0·43	31·9	0·30	14·4*	0·22
	(2) Some times weekly	6548	126	1564	30	210	4·2	55·4	1·25	58·2	1·44	52·9	0·41	31·9	0·29	14·7	0·22
	(3) Less than once weekly	6481	142	1548	34	207	4·7	54·4	1·40	59·4	1·60	52·8	0·46	31·7	0·32	15·1	0·24
	(4) Never	6452	134	1541	32	203	4·5	55·2	1·34	58·9	1·53	52·3	0·44	32·1	0·31	15·1	0·23
Total eating while watching television	(1) Less than once daily	6510	126	1555	30	207	4·2	55·2	1·26	58·9	1·43	52·6	0·41	31·9	0·28	14·9*	0·21
	(2) Once daily	6448	130	1540	31	208	4·3	54·4	1·28	56·7	1·46	53·2	0·42	31·6	0·29	14·6	0·22
	(3) Twice daily	6661	138	1591	33	214	4·6	56·4	1·37	57·8	1·57	53·0	0·45	31·9	0·31	14·3	0·23
	(4) Three or four times daily	6685	138	1599	33	213	4·7	56·8	1·39	58·6	1·59	52·7	0·45	32·1	0·31	14·5	0·24
Total television viewing per day	(0) Less than 3 h	6531	126	1560	30	209	4·1	55·0*	1·23	58·2	1·41	53·0	0·40	31·8*	0·28	14·8	0·21
	(1) 3 h or more	6615	126	1580	30	211	4·2	56·4	1·26	58·1	1·44	52·7	0·42	32·1	0·29	14·6	0·22

\*Statistically significant differences among the characteristic's groups (overall ANOVA  $F$  test): \* $P \leq 0·05$ .

†Adjusted for child's sex, mother's education level, mother's immigrant status, household annual income and child's activity level.

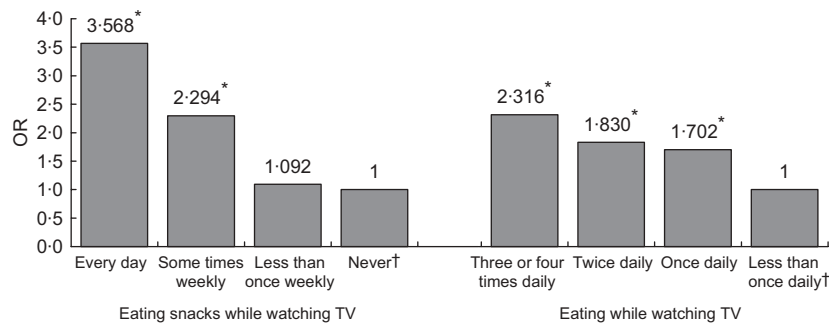
**Table 4** Adjusted† means (standard error) of food group serving consumption by frequency of eating while watching television: 2002 data on 4·5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002)

Characteristic	Category	Fruits and vegetables		Meat and alternatives		Milk products		Grain products	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Total		3·60	0·040	1·89	0·014	1·97	0·018	4·08	0·024
Eating breakfast while watching television	(1) Every day	3·15	0·176	1·91	0·066	1·99	0·085	4·04	0·102
	(2) Some times weekly	3·13	0·175	1·93	0·066	1·91	0·085	3·94	0·102
	(3) Less than once weekly	3·00	0·190	1·94	0·071	1·92	0·092	3·95	0·111
	(4) Never	3·30	0·171	1·95	0·064	1·95	0·083	3·93	0·100
Eating lunch while watching television	(1) Every day	3·07	0·214	1·92	0·080	2·02	0·103	4·10	0·124
	(2) Some times weekly	3·02	0·178	1·91	0·066	1·99	0·086	3·90	0·103
	(3) Less than once weekly	3·24	0·183	1·87	0·068	1·89	0·088	3·99	0·106
	(4) Never	3·28	0·168	1·96	0·063	1·94	0·081	3·98	0·098
Eating dinner while watching television	(1) Every day	3·00*	0·189	1·92	0·071	2·02	0·091	4·01	0·110
	(2) Some times weekly	3·21	0·174	1·89	0·065	1·90	0·084	3·96	0·101
	(3) Less than once weekly	3·27	0·182	1·95	0·068	1·98	0·088	3·96	0·106
	(4) Never	3·23	0·170	1·96	0·064	1·93	0·082	3·96	0·099
Eating snacks while watching television	(1) Every day	3·06*	0·176	1·87	0·066	1·96	0·085	4·03	0·102
	(2) Some times weekly	3·25	0·171	1·95	0·064	1·93	0·082	3·93	0·099
	(3) Less than once weekly	3·20	0·190	1·98	0·071	1·97	0·092	3·98	0·110
	(4) Never	3·33	0·183	1·98	0·068	1·94	0·088	3·90	0·106
Total eating while watching television	(1) Less than once daily	3·31*	0·171	1·98	0·064	1·96	0·082	3·93	0·099
	(2) Once daily	3·15	0·175	1·88	0·065	1·87	0·084	3·97	0·101
	(3) Twice daily	3·27	0·187	1·93	0·070	1·92	0·090	3·95	0·109
	(4) Three or four times daily	2·96	0·190	1·89	0·071	2·02	0·091	4·02	0·110
Total television viewing per day	(0) Less than 3 h	3·34*	0·167	1·93	0·063	1·94	0·081	3·96	0·098
	(1) 3 h or more	2·97	0·171	1·93	0·064	1·96	0·083	3·98	0·100

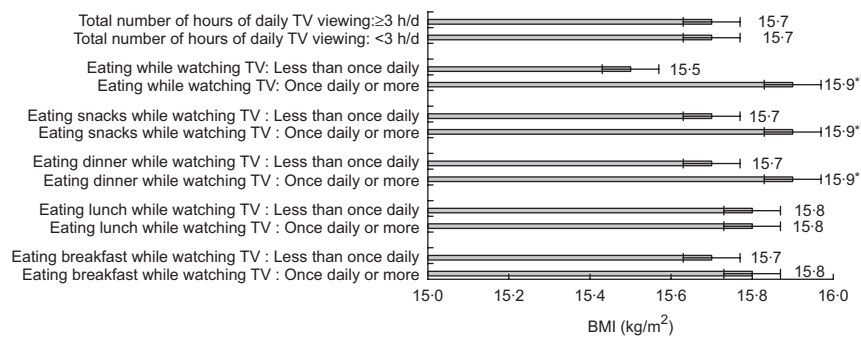
\*Statistically significant differences among the characteristic's groups (overall ANOVA *F* test): \* $P \leq 0\cdot05$ .

†Adjusted for child's sex, mother's education level, mother's immigrant status, household annual income and child's activity level.





**Fig. 2** Adjusted odds ratio for drinking soft drinks every day by eating snacks while watching television and total frequency of eating while watching television: 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002). Odds adjusted for child’s sex, mother’s education level, mother’s immigrant status, household annual income and child’s activity level; † indicates the reference category. Statistically significant association between the characteristic and the dependent variable: \* $P < 0.0001$



**Fig. 3** Mean BMI of children according to hours spent watching television and their eating practices during television viewing: 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002). Data are means with their standard errors represented by horizontal bars. Statistically significant difference in BMI between the characteristic’s groups: \* $P \leq 0.05$

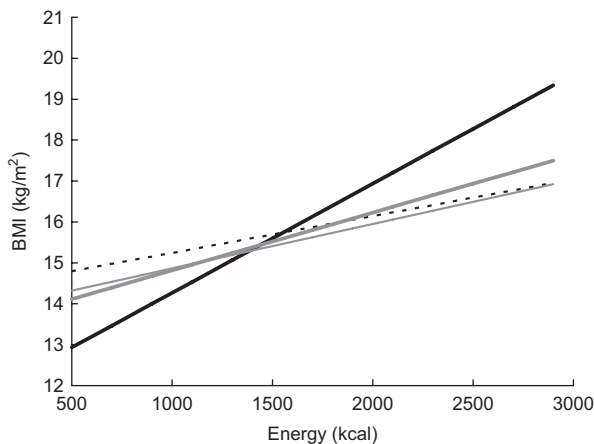
watching television and for those who did so less than once weekly or some times weekly. When children ate snacks in front of the television every day, mean BMI increased significantly by increased energy consumption, denoting a strong relationship between BMI and energy consumption. By adjusting for energy consumed, for example 2500 kcal/d, we were able to show that the mean BMI of children who consumed snacks every day while watching television was higher than that of children who ate snacks less frequently during television viewing. The same was true for the association between BMI and carbohydrate intake (Fig. 5), where a statistically significant difference was observed between children who never ate snacks in front of the television and those who ate during television viewing on a daily basis.

**Discussion**

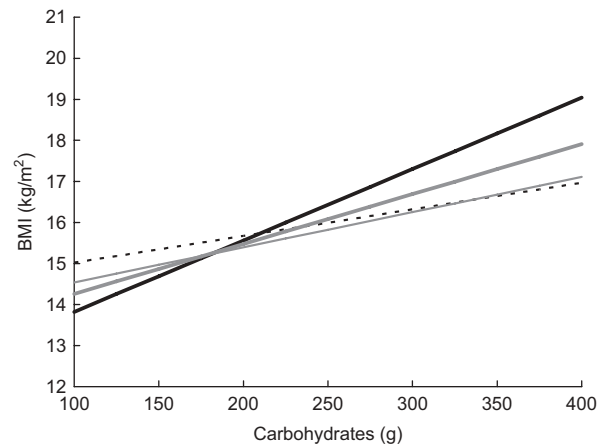
This is one of few studies that examines how social factors are associated with pre-school children’s food consumption patterns during television viewing. Our findings indicate that over one-third of children from our study population ate during television viewing at least

once daily while nearly one-quarter of children did so at least twice daily. It was also found that children tend to eat breakfast and snacks more often while watching television than any other meal. Similarly another study reported higher television viewing during snacks, with a significant proportion of children’s daily energy intake consumed during television viewing<sup>(37)</sup>, while a recent study found that television viewing can either increase or decrease pre-school children’s food intakes<sup>(38)</sup>. We found that boys watch more television and eat more frequently during television viewing than girls. Other studies reported similar gender differences in television viewing and eating behaviours<sup>(37,39,40)</sup>.

The family environment is key for developing healthy lifestyles and behaviours<sup>(41)</sup>. The present study found that a larger proportion of children from mothers with lower socio-economic status watched more television and more frequently during meals and snacks. This concurs with other studies which report that children with more educated parents watch fewer hours of television than children with less educated parents<sup>(39,42–44)</sup>. Given that this was not an observational study, we are unable to provide specific information on contextual factors related to higher television use during meals among lower-income



**Fig. 4** BMI and daily energy intake by frequency of eating snacks while watching television (—, every day; ----, some times weekly; —, less than once weekly; ···, never): 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002). BMI adjusted for child's sex, mother's education level, mother's immigrant status, household annual income and child's activity level; to convert to kJ multiply kcal by 4.1868



**Fig. 5** BMI and carbohydrate intake by frequency of eating snacks while watching television (—, every day; ----, some times weekly; —, less than once weekly; ···, never): 2002 data on 4-5-year-old pre-school children from the Longitudinal Study of Child Development in Québec (1998–2002). BMI adjusted for child's sex, mother's education level, mother's immigrant status, household annual income and child's activity level

families. Parents are role models for their children, and the amount of television viewed by the household may be a reflection of the parents' television viewing behaviours. Some families may be 'constant television households'<sup>(45)</sup>. However, it is not known for the present study whether certain families were 'high volume television viewers' relying on television viewing as a recreational activity. It is also not known to what degree parents in our study limited the amount of television being viewed by their children. One study reported that girls watched more television when their parents were also high volume television viewers<sup>(7)</sup>. Moreover, it was not determined how many televisions were in the household and whether some children had a television set in their bedroom. Dennison and colleagues found that low-income pre-school children with a television set in their room were more likely to spend more time watching television and to be overweight<sup>(46)</sup>. The present study found that children who did not attend day care tended to eat during television viewing more frequently than children who attended day care. These results were somewhat expected given that the amount of television viewed, if any, in public day-care settings is regulated. Another possible reason for higher levels of television viewing among lower-income families may be due to access to parks and safety of the neighbourhood. In another study, it was found that mothers who perceived their neighbourhood as being unsafe reported higher levels of television viewing for their children in comparison to children whose mothers perceived their neighbourhood as safe<sup>(47)</sup>. Given that parents are important change agents, particularly for shaping the behaviour of young children, the development of effective strategies for

reducing the frequency with which children eat while watching television is warranted.

The present study indicates that children who ate snacks while watching television on a daily basis had lower-quality diets. These children consumed more carbohydrates in total and less energy from proteins, fewer fruits and vegetables and more soft drinks in comparison to children who never ate snacks during television viewing. Children who watched television for 3 h or more daily also consumed a greater amount of fat. These findings concur with other studies that report television viewing is associated with increased dietary intake of high-fat and energy-dense foods<sup>(37,39,44,48–50)</sup>, a lower intake of fruits and vegetables<sup>(13,51–54)</sup> and a higher consumption of soft drinks<sup>(39,55)</sup>. Findings from our study suggest there may be a cluster of behaviours reflecting an obesogenic environment that may be contributing to overweight and obesity among these pre-school children. Future intervention studies designed to disentangle the effects of dietary intakes and other factors from the effects of television viewing are recommended.

The present study also found that children who ate snacks while watching television every day had higher BMI than children who did so less frequently. By adjusting for energy, our study revealed an association between children's daily consumption of snacks during television viewing and a higher BMI. It is possible that children in the present study who watched more television replaced physical activity. Although children's level of physical activity was not objectively measured, only 5–10% of mothers of overweight children perceived their child's activity level to be equal to or higher than that of same-aged children, whereas over 40% of mothers perceived their overweight child as less active than children of the

same age and sex (data not presented). Similarly, other studies report that increased television watching may result in reduced energy expenditure or an increase in sedentary behaviour<sup>(44,48,56,57)</sup>.

Another effect of eating during television viewing is the influence of food advertisements on children's food preferences, consumption and parental purchasing behaviour<sup>(49,58-62)</sup>. However, other studies found a weak to modest effect on children's food consumption patterns<sup>(37,63)</sup>. Food is the most heavily advertised product category during children's television programming<sup>(61,64,65)</sup> and these foods tend to be higher in fat, sugar and/or salt more often than more healthful choices<sup>(39,59,61,64,66,67)</sup>. Although the direct effect of food advertising on the dietary intake of children could not be determined, a relationship with higher intake of carbohydrates, fat, fewer fruits and vegetables, and soft drinks among high television viewers was observed. It is likely that children who watch more television are exposed to more food advertisements in comparison to those who watch less television and this may have an effect on diet quality. More research related to the direct effects of food advertising (e.g. dose, frequency, content of programmes) on children's food-related behaviour is warranted.

The present study has important strengths due to its large sample size and representative nature of the study population. Additionally, both children's heights and weights were objectively measured to calculate an indicator of BMI. There are also some limitations to our study. Although 24 h dietary recalls are recognized as the best method to estimate dietary intake, including macronutrients, some limitations include the reliance on participants' memory, how well selected days represents usual intake, and the possibility of under-reporting food intakes<sup>(68)</sup>. The 24 h recall is considered reasonably accurate for providing group mean estimates of children's dietary intakes while being less burdensome and invasive than food records<sup>(69)</sup>.

Another limitation is related to using one survey question to measure children's level of physical activity. Using such a method has limitations because it does not empirically measure children's energy expenditures, it does not consider the amount of time being physically active, and does not measure the type of physical activity<sup>(69,70)</sup>. A number of studies have also shown that overweight or obese individuals tend to under-report their dietary intake to a greater extent than lean individuals<sup>(71-73)</sup>. Likewise, parents may be under-reporting their children's intake, particularly for snacks rather than meals. Other studies found that snack foods are more commonly under-reported than foods consumed at regular meals<sup>(74)</sup>.

The reliance on parental reports for children's television viewing practices and other television-related behaviours may also act as a limitation. It is possible that parents may have felt pressure to report socially desirable behaviours, leading to an under-reporting of their child's

television viewing practices. Another limitation of the study is that potential effect of food advertising could not be disentangled from the general effect of television viewing, although this does not rule out the possibility that food advertising contributed to the relationship.

In summary, the present study found associations between eating meals and snacks during television viewing, a higher frequency of television viewing and higher mean BMI among pre-school children in comparison to children who never ate while watching television. Children who ate snacks in front of the television every day consumed more carbohydrates and less energy from proteins, fewer fruits and vegetables and more soft drinks compared with children who never ate snacks during television viewing.

## Conclusion

These findings support previous studies which show that eating while watching television may be a potential mechanism linking television viewing to obesity among pre-school children. Given that an association was found between television viewing and body weight among pre-school children, particularly among those from less educated, lower-income families and younger mothers, health professionals should target parents of children at risk of overweight/obesity with focused messages and strategies to help children change the types of foods consumed during television viewing and to reduce time spent watching television.

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*Authorship responsibilities:* L.D. is the director of the study (questionnaire development, data analysis, interpretation of the data, etc.). M.G. planned and performed the statistical data analysis. A.F. and K.P. contributed to literature review, content analysis and writing of the manuscript.

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