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## Screen time is associated with dietary intake in overweight Canadian children☆☆☆☆

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## ABSTRACT

**Objectives.** To describe the relationship between screen time and dietary intake among children, and to examine this association in relation to body weight.

**Methods.** A cross-sectional analysis of 630 Canadian children aged 8–10 years with at least one obese biological parent. Measurements included body mass index (BMI), screen time (television, video game, computer), physical activity (accelerometer over 7 days), and diet (three 24-hour recalls for the calculation of the Canadian Healthy Eating Index (HEI-C)). Multivariate linear regression models were used to describe the relationship between screen time ( $\geq 2$  h/d vs.  $< 2$  h/d) and intake of nutrients and foods among healthy weight and overweight/obese children.

**Results.** The overall median [interquartile range] daily screen time was 2.2 [2.4] hours and 43% of children had a BMI of  $\geq 85$ th percentile. Longer screen time above the recommendation ( $\geq 2$  h/d) was associated with higher intake of energy (74 kcal, SE = 35), lower intake of fiber ( $-0.6$  g/1000 kcal, SE = 0.2) and vegetables & fruit ( $-0.3$  serving/1000 kcal, SE = 0.1) among all participants and with higher estimates in the overweight subgroup. An overall lower HEI-C ( $-1.6$ , SE = 0.8) was also observed among children with screen time of  $\geq 2$  h/d. Among children of  $< 85$ th BMI percentile, longer screen time was associated with lower intake of vegetables & fruit ( $-0.3$  serving/1000 kcal, SE = 0.1) only.

**Conclusion.** Screen time is associated with less desirable food choices, particularly in overweight children.

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**Abbreviations:** BMI, body mass index; QUALITY, Quebec Adiposity and Lifestyle Investigation in Youth; SSB, sugar-sweetened beverage.

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★ What is known on this subject: Many studies show that screen time is related to high energy intake and poor nutrient and/or food choices.

★★ What is new: We found that this association was more evident among overweight/obese children.

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## Introduction

Obesity results from an imbalance of energy intake and expenditure (DeLany, 1998; Institute of Medicine, 2002). Sedentary behavior, physical activity, excessive fat intake, frequent intake of fast-food and sugar-sweetened beverages (SSB, including but not limited to soft drinks, fruit drinks, energy drinks, and sweetened tea consumption; but not diet drinks or 100% fruit juice), and inadequate vegetables & fruit intake (Neumark-Sztainer et al., 2003; Rennie et al., 2005; Hills et al., 2010) all contribute to energy imbalance.

Several cross-sectional (Utter et al., 2006; Kremers et al., 2007; Scully et al., 2007; Pearson and Biddle, 2011) and prospective studies (Wiecha et al., 2006; Barr-Anderson et al., 2009) report co-occurrence of unhealthy dietary behaviors and TV viewing in children. Longer TV

hours were associated with consumption of more soft drinks and non-whole-grain products (Ng et al., 2010). Short-term experimental studies also show that higher screen time (including watching TV/videos, playing videogames, etc.) can lead to increased energy intake among healthy weight youth (Epstein et al., 2005; Chaput et al., 2011). Among children, there may be different patterns of susceptibility to the influence of TV/computer use on other behaviors, such as the quantity and types of foods eaten (Klepp et al., 2007; Ng et al., 2010). In a review on environmental factors affecting food consumption, Wansink (2004) highlights the impact of distraction on increasing food intake, with overweight/obese individuals having a greater tendency for distractibility (Rodin, 1973).

The present study aims to increase understanding of the link between sedentary behavior (more specifically, screen time) and dietary intake in youth. We analyzed baseline data from the Quebec Adiposity and Lifestyle Investigation in Youth (QUALITY) study (a cohort study which examines lifestyle factors and health in children at risk of obesity) in order to (1) describe the association between screen time and food consumption behaviors, and (2) test whether these associations vary according to weight status (healthy weight vs. overweight/obese).

## Methods

The baseline sample included 630 children enrolled in the QUALITY cohort, a familial study on the determinants of cardiovascular disease and type 2 diabetes in children (Lambert et al., 2012). Caucasian children aged 8–10 years, with at least one obese biological parent were included. Families were recruited through schools located within 75 km of Montreal, Quebec City or Sherbrooke (Canada). The baseline examination took place from 2005 to 2008. This project was approved by the ethics review boards at Centre Hospitalier Universitaire Sainte-Justine and Université Laval. Written informed parental consent and children's assent were obtained.

### Anthropometric and demographic characteristics

Height and weight were measured using standardized measurement methods (Lohman et al., 1988; Paradis et al., 2004). Age- and sex-specific BMI percentiles were computed according to the United States Centers for Disease Control growth charts (CDC Growth Charts, 2000). Children were categorized as overweight if their BMI was  $\geq 85$ th age- and sex-specific percentile. Self-administered questionnaires to both parents were used to collect demographic data (Paradis et al., 2003), including annual household income and parents' educational attainment.

### Dietary assessment

Mean values for the quantity of foods and nutrients consumed were obtained from three 24-hour food recalls collected by telephone interview with the child by trained dietitians (98% of participants had 3 recalls, 2% had 2 recalls) (Obarzanek et al., 2001). Parents were asked for details of food preparation when needed. Data were collected on 2 weekdays and 1 weekend day, 8–12 weeks after recruitment.

Foods reported on the 24-hour recalls were entered into the CANDAT software (Candat, London, ON, Canada) and converted to nutrients using the 2007b Canadian Nutrient File (Health Canada, 2007). Every 10th entry was audited for accuracy by a dietitian. All entries were verified for outlying values to provide further verification of the food codes and portion sizes used.

Foods were categorized into 2 healthy groups (vegetables & fruit, dairy products) and 2 unhealthy groups (SSB and hamburger/hot dog/pizza). The Healthy Eating Index (HEI) is a measure of overall diet quality that assesses adherence to the Dietary Guidelines for Americans (Guenther et al., 2008). Nutrients examined included energy, total fat, added sugar, fiber and sodium. In Canada, an index similar to the HEI,

the HEI-C (Woodruff and Hanning, 2010) was adapted based on the latest dietary recommendations, Eating Well with Canada's Food Guide (Katamay et al., 2007). The HEI-C includes 9 components with a continuous score assigned to each component, for a maximum score of 100. Scores for intake between the minimum (0 points) and maximum standards (10 or 20 points) are calculated in proportion to the scoring scheme. The higher the total score, the better the overall diet quality.

### Physical activity

An accelerometer (Actigraph LLC, Pensacola, FL, USA) was worn by each child for 7 consecutive days to estimate usual physical activity. We defined non-wear time as any period of 60 min or more of 0 counts, with 1 interruption (one minute duration) or 2 consecutive interruptions (2 consecutive minutes). An interruption was defined as a minute when count values were  $>0$  and  $\leq 100$  (Troiano et al., 2008). A minimum wear time of 10 h was required for the recordings of a given day to be considered a valid representation of activity, with a minimum of 4 valid days (Puyau et al., 2002; Corder et al., 2011).

Daily screen time was computed based on the child's report of time spent watching TV, playing videogames or using the computer for leisure on weekdays and weekend days (Paradis et al., 2003). Total screen time in a typical week was computed by calculating the weighted mean daily screen time. To compare screen time with national guidelines, respondents were categorized as engaging in low ( $<2$  h/d) or high ( $\geq 2$  h/d) screen time based on the American Academy of Pediatrics guidelines for daily TV viewing (American Academy of Pediatrics, 2001; The Canadian Society for Exercise Physiology, 2011) and Kaiser Family Foundation definition of high TV use (Roberts et al., 2005).

### Statistical analyses

Independent *t*-tests and  $\chi^2$  tests were used to compare continuous and categorical variables respectively in the 2 screen time groups. Multivariate linear regression was performed with all energy adjusted food groups and nutrients (per 1000 kcal) as dependent variables and screen time ( $<2$  h/d vs.  $\geq 2$  h/d) as an independent variable. Potential confounders included age, sex, physical activity, mothers' BMI, annual household income and highest parental education attainment. All assumptions for linear regression have been met. Bonferroni correction (Gelman et al., 2012) was also used for adjusting the multiple comparisons ( $P < 0.0025$ ). Analyses were performed with SPSS 16.0 (SPSS, Inc., Chicago, IL, USA) and STATA 11.0 (StataCorp LP, College Station, TX, USA).

## Results

The median of daily screen time was 2.2 h [interquartile range 2.4 h] for QUALITY participants. Children were aged 9.6 years on average, 54.4% were boys and 43% were overweight ( $\geq 85$ th BMI percentile). The characteristics and daily dietary intake of the children by screen time level are shown in Table 1. The participants in the high screen time group were older, heavier, and with a higher percentage of boys. There were also more mothers with a higher BMI and less parents holding a university degree in the high screen time group. Participants in the high screen time group had higher intakes of overall energy and sodium, and lower intakes of fiber and vegetables & fruit.

The association between screen time and dietary intake was further analyzed using multivariate linear regression models for all children and in two subgroups – normal weight and overweight (Table 2, due to missing data, altogether 521 out of 630 children were included in the analysis). Among all children and overweight participants, those watching  $\geq 2$  h/d of screen time had higher intakes of energy, lower intakes of fiber and vegetables & fruit, after controlling for age, sex, physical activity, mothers' BMI and socioeconomic status (household

**Table 1**  
Comparison of characteristics and dietary intake of QUALITY<sup>a</sup> subjects between 2 screen time groups.

	Screen time <sup>b</sup>				P-value
	Low (n = 226)		High (n = 295)		
	Mean	SD	Mean	SD	
<b>Children</b>					
Age (year)	9.5	0.9	9.7	0.9	0.003
Boys (%)	45		62		<0.001
Children's BMI (kg/m <sup>2</sup> )	18.4	3.4	20.4	4.8	<0.001
Overweight/obese (%)	34		49		<0.001
Screen time (h/d) <sup>c</sup>	1.2	0.7	3.6	2.4	<0.001
Physical activity (counts/min)	594	188	582	184	0.430
<b>Parents</b>					
Mothers' BMI (kg/m <sup>2</sup> )	28.8	6.1	30.0	7.0	0.031
Fathers' BMI (kg/m <sup>2</sup> )	30.3	5.5	31.0	5.4	0.146
Household income	43,763	17,883	40,929	19,390	0.064
Parent holding a university degree (%)	61		50		0.005
<b>Children's dietary intake</b>					
Energy (kcal)	1639	387	1722	395	0.010
Total fat (g/1000 kcal)	36	5.8	36	5.1	0.411
Total added sugar (g/1000 kcal)	29	11	30	12	0.290
Fiber (g/1000 kcal)	8.4	2.1	7.7	2.0	<0.001
Sodium (mg/1000 kcal)	1422	304	1484	349	0.019
Sugar-sweetened beverages (mL/1000 kcal)	79	93	87	90	0.282
Hamburger/hot dog/pizza (g/1000 kcal)	15	24	17	28	0.244
Vegetables & fruit (serving/1000 kcal)	2.8	1.3	2.5	1.3	0.004
Dairy products (serving/1000 kcal)	1.2	0.5	1.1	0.5	0.098
HEI-C <sup>d</sup>	79	9.8	78	9.3	0.119

SD = standard deviation.

<sup>a</sup> QUALITY = Quebec Adiposity and Lifestyle Investigation in Youth.

<sup>b</sup> Screen time was categorized into 2 groups: low (<2 h/d) and high (≥2 h/d).

<sup>c</sup> Screen time is displayed as median and interquartile range, since it is not normally distributed.

<sup>d</sup> HEI-C = Canadian Healthy Eating Index.

income and parents' education). An overall lower HEI-C score was also observed among those children with longer screen time and higher estimates were observed especially among overweight children. Among those with a BMI of ≤85th percentile, longer screen time was associated with lower intakes of vegetables & fruit only. No significant associations

were observed between screen time and intake of other food groups or nutrients.

**Discussion**

Our results suggest that screen time is associated with dietary quality HEI-C and vegetable & fruit consumption and the association of screen time and extra energy intake is stronger among the overweight children. Among heavier children, the difference in energy intake from low (<2 h) to high (≥2 h) screen time groups was 136 kcal, and this extra energy came predominantly from lower nutrition dense foods (with less fiber content and less vegetables & fruit).

Most cross-sectional and several prospective studies in youth report that TV viewing/screen time is associated with higher energy intake (Wiecha et al., 2006; Epstein et al., 2008; Manios et al., 2009), lower vegetable & fruit consumption (Utter et al., 2006; Scully et al., 2007; Barr-Anderson et al., 2009), higher SSB consumption (Utter et al., 2006; Wiecha et al., 2006; Kremers et al., 2007; Scully et al., 2007; Barr-Anderson et al., 2009), higher fast food intake (Utter et al., 2006; Wiecha et al., 2006; Scully et al., 2007; Barr-Anderson et al., 2009), and higher snack and fried food consumption (Wiecha et al., 2006; Barr-Anderson et al., 2009). Our findings were generally consistent with previous evidence and specifically we found that the associations were apparent mainly among overweight/obese children.

In addition, previous studies have shown that children's dietary habits and leisure-time activities are also influenced by their parents (Fisher et al., 2002; Gruber and Haldeman, 2009). The strengths of our study include controlling for both individual as well as parental-level confounders. The associations between screen time and dietary intake (total energy, fiber, and vegetables & fruit) were not attenuated after adjustment of mother's BMI and socioeconomic status (household income and parents' education) among all children. Further, we used three 24 hour diet recalls to capture both food and nutrient data, and evaluate overall dietary quality using HEI-C. Although the statistical significance of HEI-C was attenuated in the overweight subgroup after adjustment of parents' BMI and socioeconomic status, it showed the same direction with an even higher estimate.

Many studies agree that screen time might act in several ways to influence dietary behaviors in children. One is through food advertising. Fast foods, high-fat, high-sugar foods, and SSB are heavily advertised during prime time programs (Institute of Medicine, 2005) and this

**Table 2**  
Multivariate linear regression analyses of the association between screen time and dietary intake stratified by 85th BMI percentile.

	All individuals (n = 521)				<85th BMI percentile (n = 312)				≥85th BMI percentile (n = 209)			
	β <sub>1</sub>	SE <sub>1</sub>	β <sub>2</sub>	SE <sub>2</sub>	β <sub>1</sub>	SE <sub>1</sub>	β <sub>2</sub>	SE <sub>2</sub>	β <sub>1</sub>	SE <sub>1</sub>	β <sub>2</sub>	SE <sub>2</sub>
<b>Nutrients</b>												
Energy (kcal)	82**	32	74*	35	71	45	22	45	95	53	136*	58
Total fat (g/1000 kcal)	0.4	0.4	0.5	0.5	-0.2	0.6	-0.1	0.7	1.2	0.7	1.3	0.7
Total added sugars (g/1000 kcal)	1.0	0.9	1.0	1.1	1.3	1.3	1.2	1.4	1.2	1.4	0.9	1.6
Fiber (g/1000 kcal)	-0.7***	0.2	-0.6***	0.2	-0.5**	0.2	-0.4	0.2	-1.1***	0.3	-1.1***	0.3
Sodium (g/1000 kcal)	62*	27	40	30	23	35	29	39	75	43	55	50
<b>Food groups</b>												
Sugar-sweetened beverages (mL/1000 kcal)	8.0	7.4	1.0	8.3	7.8	9.6	2.8	10.6	7.1	12.2	0.1	14
Hamburger/hot dog/pizza (g/1000 kcal)	2.7	2.3	3.1	2.4	0.2	3.1	2.7	3.2	6.5	3.8	4.1	4.2
Vegetables & fruit (serving/1000 kcal)	-0.3*	0.1	-0.3*	0.1	-0.3*	0.1	-0.3*	0.1	-0.3*	0.2	-0.2*	0.2
Dairy products (serving/1000 kcal)	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.01	0.01
HEI-C <sup>a</sup> (score)	-1.2*	0.8	-1.6*	0.8	-0.8	1.0	-1.7	1.1	-2.2*	1.2	-1.6	1.3

β<sub>1</sub>: in comparison to the screen time group (<2 h/d), unadjusted.

β<sub>2</sub>: in comparison to the screen time group (<2 h/d), adjusted for covariates including age, sex, physical activity, mothers' BMI, household income, and parents' education (holding a university degree).

SE: standard error for beta coefficient.

<sup>a</sup> HEI-C = Canadian Healthy Eating Index.

\* P < 0.05.

\*\* P < 0.01.

\*\*\* P < 0.001.

advertising may influence children's food preferences. Alternatively, screen viewing may influence eating behaviors through food messages embedded within program content (Story and Faulkner, 1990). Several experimental studies show that higher screen time leads to increased energy intake in healthy weight youth (Epstein et al., 2005). After playing videogames healthy weight adolescents ate more at an ad libitum food offer and did not compensate for the higher energy intake later in the day (Chaput et al., 2011). A study among 4–7 year old overweight/obese children (Epstein et al., 2008) showed that decreasing screen time leads to a decrease in energy intake. Another experimental study among children aged 9–11 years reported that watching food advertisements on television increased food intake, particularly in overweight/obese children; obese children increased their consumption by 134%, overweight children by 101% and normal weight children by 84% (University of Liverpool, 2007). At last, longer screen time has been linked to short sleep duration and depression among youth (Costigan et al., 2013), which consequently has potential influence on food choices and quantity (Chahal et al., 2013; Stea et al., 2014).

Interpretation of our study should consider several limitations. This study was cross-sectional, so no causal inference could be made and the possible mechanism is not clear. Although our data collection strictly followed the detailed manual procedure to guarantee the quality control (QUALITY Cohort Technical Documents, 2011), potential bias and errors may still exist in those self-reported questionnaires. A number of potential confounding factors have been adjusted in the regression models, but the results may still be confounded by other known and unknown factors. In addition, this study was not designed to use a nationally or regionally representative sample, of which the results may be limited by their generalizability. Prospective studies, with more socio-demographically diverse populations and inclusion of other factors that may influence dietary behaviors are needed, as are trials of eating behaviors in response to different types of activities or stimulation.

Our findings suggest the association between screen time and children's dietary intake may depend on their weight status or possibly other characteristics (such as appetite, food availability, etc.) linked to weight status. Health care professionals treating overweight children should inquire about screen time and encourage current recommendations (less than 2 h daily).

### Conflict of interest

All authors have no conflicts of interest to disclose.

### Contributor's statements

Lei Shang: Dr. Shang conceptualized and designed the study, conducted the initial analyses, drafted the initial manuscript and approved the final manuscript as submitted.

JiaWei Wang: Dr. Wang carried out the analyses, reviewed and revised the manuscript and approved the final manuscript as submitted.

Jennifer O'Loughlin, Angelo Tremblay, Marie-Eve Mathieu and Mélanie Henderson: Drs. O'Loughlin, Tremblay and Henderson reviewed and revised the manuscript, and approved the final manuscript as submitted. Drs. Wang, Mathieu and Henderson proposed various analytic strategies, particularly around the accelerometry data.

Katherine Gray-Donald: Dr. Gray-Donald conceptualized and designed the study, oversaw the dietary data collection, reviewed and revised the manuscript, and approved the final manuscript as submitted.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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