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Mediating role of disordered eating in the relationship between screen time and BMI in adolescents: longitudinal findings from the Research on Eating and Adolescent Lifestyles (REAL) study

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Abstract

Objective: This study investigated whether the duration and type of screen time (ST) (TV viewing, recreational computer use, video gaming) is longitudinally associated with *z*-BMI and if these relationships are mediated by disordered eating (emotional, restrained).

Design: At baseline, participants were *n* 1197 (T1; 60 % female) adolescents (mean age = 13·51 years) who completed surveys over 2 years. ST was assessed by a self-reported measure created by the investigative team, while emotional and restrained eating was measured by the Dutch Eating Behaviour Questionnaire (DEB-Q). Height and weight were objectively measured to quantify *z*-BMI.

Setting: Thirty-one public and two private schools from the region of Ottawa, Canada.

Participants: Students in grades 7–12.

Results: Parallel multiple mediation analyses revealed that more time spent watching TV at baseline is associated with higher *z*-BMI at T3 (total effect; $B = 0{\cdot}19$, SE = 0·07, $P = 0{\cdot}01$, 95 % CI 0·05, 0·34), but no relationships were observed for total ST exposure or other types of ST and *z*-BMI. Disordered eating did not mediate the positive association between baseline TV viewing and *z*-BMI at T3.

Conclusions: TV viewing was longitudinally associated with higher *z*-BMI in a community-based sample of adolescents, but disordered eating behaviours did not mediate this relationship. However, other non-pathological eating behaviours may mediate the association between ST and obesity and warrant further investigation. Finding suggests that targeting reduction in youth's TV viewing may be an effective component in the prevention of childhood obesity.

Keywords
BMI
Screen time
Obesity
Disordered eating

Paediatric obesity represents a serious public health issue due to its high and growing prevalence in westernized countries and its association with an increased risk of morbidity, mortality, disability[1–3] and economic burden on healthcare systems[4,5]. Thus, identifying modifiable determinants can inform prevention, which is especially important given the majority of youth with obesity remain obese as adults[6–9].

Exposure to various screens, such as television, computers, smartphones, tablets, or video games, is also increasing dramatically, with North American children engaging in an average of 6–8 h/d of screen time (ST)[10,11]. The Canadian 24-h Movement Guidelines for Children and Youth aged 5–17[12] recommend no more than 2 h/d of recreational ST. According to population-based research with nationally representative samples, the vast

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majority of North American children do not meet these guidelines[13,14].

Recent literature shows that excess ST in children is correlated with an increased risk of obesity[15–17] and cardiometabolic diseases[18–20]. However, the vast majority of studies used cross-sectional designs and showed consistent but weak associations, and the few longitudinal studies assessing the association between ST, adiposity and BMI[16,21–29] reported mixed findings[30]. The inconsistent results could be due to different outcome measures, whereby some studies examined TV viewing in association with markers of adiposity, which tended to show weaker or null associations, while other studies measured BMI, which tended to show stronger associations[31,32]. Most of the research is limited to small sample sizes and cross-sectional designs, restricting causal inferences; not measuring different types of screen exposure (TV, computer, video games); and most relied on self-reported BMI, known to yield biased estimates[33]. Furthermore, only a few observational studies used standardized BMI that corrects for growth and development.

The underlying mechanisms by which ST may confer obesity risk are unclear; however, the majority of studies, albeit based on cross-sectional studies, indicate increased food intake to be the primary driver. Evidence from laboratory studies shows that ST may lead to increased eating[34,35] in the absence of hunger and subsequent weight gain due to classical conditioning[36,37]; distraction from internal sensations of hunger and satiety; and food-related commercials or advertising that are common on TV, Internet and social media sites[38]. However, very little research has examined whether the pattern of excess energy intake in response to screen exposure is characteristic of disordered eating behaviours, such as restrained eating (restricting food to lose weight) or emotional eating (eating to modulate emotions), both of which have been associated with the development of eating disorders and obesity in youth[39]. This question is relevant to explore given that TV viewing and Internet use exposes youth to innumerable social comparisons and unattainable societal standards of attractiveness that have been shown to be associated with psychological distress[40], body dissatisfaction especially among females[41] and weight gain[42]. Moreover, sedentary video game playing has also been implicated in having a negative impact on eating behaviours in youth, primarily in the form of increased energy intake, especially in boys who show greater use[43]. However, disordered eating was not measured in these studies.

Evidence on the association between disordered eating and BMI in youth shows fairly consistent relationships. Data from cross-sectional and longitudinal[44] studies mostly support positive relationships between emotional eating and BMI, whereby higher scores on emotional eating were associated with higher BMI over time. Similarly, many cross-sectional and longitudinal studies have found positive associations between restrained eating and BMI[39,45–48], consistent with the restraint theory that posits that dietary restraint will eventually break down and lead to overcompensation of food intake or binge eating leading to weight gain. Taken together, this suggests that restrained eating and emotional eating may play a mediating role in the relationship between ST and weight gain over time, but this has not been directly tested using a longitudinal design. Gaining a better understanding of the temporal relationships between ST, eating behaviours and BMI is critical to optimally inform future interventions designed to enhance the prevention and treatment of disordered eating and obesity during adolescence, which is known to be a high-risk period of development for obesity[1–4].

Accordingly, the purposes of the present study were: (1) to examine the longitudinal association between duration (total ST) and type of screen exposure (TV, computer, video games) at baseline and *z*-BMI 2 years later in a large, community-based sample of adolescents; and (2) to examine the extent to which disordered eating behaviours (restrained and emotional eating) mediate these relationships. Therefore, we hypothesized that spending great time in overall recreational ST and each type (TV, computer use, video games) at baseline would significantly predict *z*-BMI at T3, and that these associations would be mediated by restrained and emotional eating at T2.

Method

Participants and procedure

Data in the present study were drawn from the Research on Eating and Adolescent Lifestyles (REAL) study, a large community-based longitudinal study[49]. Four school boards in the Ottawa, Ontario region (the Ottawa-Carleton District School Board; the Upper Canada District School Board; Conseil des Écoles Publiques de l'Est de l'Ontario; and the Ottawa Catholic School Board), in addition to several private schools were invited to participate in the study. A total of thirty-two public, seven catholic public, two private schools and two alternative schools agreed to participate.

The analytic sample in this study consisted of 1197 participants at baseline (T1; 60·3 % female), with a mean age of 13·5 years. Data were collected between April 2006 and November 2013 from twenty-five (twenty-one district public, two catholic public and two private middle and high schools in rural and urban areas) of the forty-three schools that agreed to participate. Participants were English-speaking adolescents in grades seven and nine who were followed up annually.

Students received an in-class information session about the purpose of the study and the consent process. Consent

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forms were given to all students to take home to parents to read and sign. Students completed survey questionnaires during a second visit in classrooms. Also, measurements of height and weight took place in a private area. Research personnel were present and able to answer any questions. All questionnaires were sealed in an envelope by the participants and dropped into a box to ensure confidentiality of responses. All participants provided informed consent, and relevant institutional research ethical boards approved this study. Specifically, research ethical approval to conduct this study was received from each school board, the University of Ottawa's Institute of Mental Health Research (REB# 2004–02) and the Children's Hospital of Eastern Ontario (REB# 04/09 E).

Variables

Demographics

Demographic data were collected from each participant, including age, gender and the highest level of parental education as a proxy for socioeconomic status (SES).

Screen time

Sedentary ST was measured using the Leisure-Time Sedentary Activities six-item questionnaire[50], which was developed to measure how many hours per day participants involve in watching TV, playing video games and using computers. Scores range from 0 to 5, where 0 = not at all; 1 = <1 h; 2 = 1–3 h; 3 = 3–5 h; 4 = 5–8 h; and 5 = >8 h. Total ST as well as individual ST behaviours (TV watching, computer use, video games) were separately examined. For each subscale, as well as total ST, separate items address time spent engaging in screen-based activities during a typical weekday and weekend day. Total ST and time spent on each specific screen activity were weighted as follows: ((weekday × 5) + (weekend × 2))/7. Higher scores are representative of more time engaging in sedentary screen-based activities; note that the raw score does not represent the number of hours of ST. In the present study, the scale demonstrated good reliability ($\alpha = 0{\cdot}70$).

Standardised BMI (z-BMI)

Weight was measured using a digital scale (Health-O-Meter, model 830 KL; Sunbeam Products Inc.) and recorded in kilograms to the nearest 0·1 kg. Height was measured using a stadiometer (model 217; Seca Corp.) and recorded in centimetres. BMI was calculated by dividing the individual's weight in kilograms by their height in meters-squared (kg/m^2). Age and sex-specific percentiles and the matching BMI *z*-scores were assessed using the WHO growth chart[51].

Disordered eating

Disordered eating was assessed through the Dutch Eating Behaviour Questionnaire (DEBQ)[52] that consists of thirty-three items and five-point rating scales ranging from 1 (never) to 5 (very often). DEBQ is a widely used and validated measure of three aspects of eating behaviours: emotional, external and restrained eating[53,54]. Two of three subscales were used: restrained eating (ten items) and emotional eating (thirteen items). Restrained eating was defined as restricting food intake for weight loss, which often results in compensatory eating and weight gain[55]. Emotional eating was defined as a maladaptive pattern of eating designed to cope with negative emotions such as stress and anxiety or depression[56,57]. Scores were calculated by averaging each item within their respective subscales, where higher scores reflect more severe disordered eating behaviours. In the present study, emotional and restrained eating subscales demonstrated excellent reliability ($\alpha = 0{\cdot}92$–$0{\cdot}94$).

Data analysis

All analysis were conducted using MPlus (version 7.31) with maximum likelihood estimation to account for missing data. Descriptive statistics and correlations were calculated to describe the sample and assess relations and directionality between all study variables. Multiple mediation analyses were conducted to test four hypothesized models – total ST, TV, computer use and video games – separately at T1 predicting *z*-BMI at T3 with restrained and emotional eating at T2 as mediators. Gender, SES and age were entered as covariates in all models. 5000 bootstrapped samples and 95 % bias-corrected CI were used to test each pathway, as well as direct, total and indirect effects. If the 95 % CI did not contain the value of 0, this would indicate statistical significance of mediation models.

Attrition rate was high (75 %) in this study, and it is considered a common methodological problem in longitudinal studies[58–62]. However, those who participated at T2 did not differ from those who did not participate in any main variables of interest ($P > 0{\cdot}05$). Those who participated at T3 had significantly higher *z*-BMI than those who did not participate ($M = 0{\cdot}47$, SD = 1·09 *v.* $M = 0{\cdot}30$, SD = 1·08; $t(1190) = 2{\cdot}34$, $P = 0{\cdot}02$, $d = 0{\cdot}17$), but groups did not differ on any other variables (data not shown).

Results

Demographics and duration of screen time

Table 1 displays the characteristics of the sample for all variables of interest. Weight status categories were determined as defined by the International Obesity Task Force guidelines[63]. The means for restrained and emotional eating were comparable with those found in studies outside of Canada[44,64]. The mean for ST among youth was 4·96 (5–8 h/d), which aligns with recent research[13]. Approximately 65 % of the sample came from well-educated families, where both parents had a college/university education.

Bivariate correlations for all covariates, predictors and outcome variables are shown in Table 2. Aggregated ST at

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Table 1 Descriptive statistics of all study variables reported as mean and SD for continuous and *n* and % for categorical variables*

Variable	*n*	%
T1 (*n* 1197)		
Age		
Mean	13·51	
SD	1·10	
Gender		
Female	722	60·3
Male	475	39·7
Weight status		
Underweight	77	6·5
Average weight	838	70·3
Overweight	216	18·1
Obese	61	5·1
Parental education	2·56	0·65
No parent attended college	108	9·0
One parent attended college	312	26·1
Both parents attended college	777	64·9
Total screen time		
Mean	4·96	
SD	2·01	
TV watching		
Mean	1·90	
SD	0·80	
Computer use		
Mean	1·85	
SD	0·96	
Video games		
Mean	1·21	
SD	0·97	
T2 (*n* 637)		
Restrained eating		
Mean	1·68	
SD	0·70	
Emotional eating		
Mean	1·82	
SD	0·80	
T3 (*n* 306)		
z-BMI		
Mean	0·30	
SD	1·04	
Weight status		
Underweight	18	5·8
Average weight	226	73·4
Overweight	51	16·6
Obese	13	4·2

*Weight status cut-off was determined as defined by the International Obesity Task Force guidelines[63].

baseline was positively associated with *z*-BMI at T3 ($r = 0{\cdot}25$, $P < 0{\cdot}05$) and emotional eating at T2 ($r = 0{\cdot}21$, $P < 0{\cdot}05$) but not restrained eating at T2. Restrained eating at T2 was positively associated with *z*-BMI at T3 ($r = 0{\cdot}31$, $P < 0{\cdot}001$), but emotional eating at T2 was not correlated with *z*-BMI. TV viewing at baseline was positively associated with *z*-BMI at T3 ($r = 0{\cdot}13$, $P < 0{\cdot}05$), as well as emotional eating at T2 ($r = 0{\cdot}14$, $P < 0{\cdot}05$), but not restrained eating at T2. Time spent playing video games and recreational computer use at baseline was not correlated with *z*-BMI at T3 or with restrained or emotional eating. Time spent in recreational computer use at baseline was positively correlated with emotional eating at T2 ($r = 0{\cdot}20$, $P < 0{\cdot}001$) but not restrained eating at T2. Time spent in video gaming at baseline was associated with restrained eating at T2 ($r = -0{\cdot}11$, $P < 0{\cdot}05$) but not emotional eating at T2.

Multivariate modelling of effects of screen time on z-BMI through disordered eating

Total screen time

As shown in Fig. 1, based on multiple parallel mediation analyses, greater ST at T1 showed a non-significant finding toward predicting higher *z*-BMI at T3 (total effect; $B = 0{\cdot}06$, SE = 0·03, $P = 0{\cdot}06$, 95 % CI –0·007, 0·13). Further, total ST at T1 was not associated with restrained or emotional eating at T2 (*p*'s > 0·33). Only restrained eating at T2 was positively associated with *z*-BMI at T3 ($B = 0{\cdot}43$, SE = 0·12, $P < 0{\cdot}001$). Tests of total and specific indirect effects were non-significant, indicating no mediation had occurred (see Table 3).

Television viewing

As shown in Fig. 2, multiple parallel mediation analyses showed that greater TV viewing at T1 predicted higher *z*-BMI at T3 (total effect; $B = 0{\cdot}19$, SE = 0·07, $P = 0{\cdot}01$, 95 % CI 0·05, 0·34). However, TV viewing at T1 was not associated with restrained or emotional eating at T2 (*p*'s > 0·18). Only restrained eating at T2 was positively associated with *z*-BMI at T3 ($B = 0{\cdot}43$, SE = 0·12, $P < 0{\cdot}001$). Tests of total and specific indirect effects were non-significant, indicating no mediation had occurred (see Table 3).

Computer use

As shown in Fig. 3, multiple parallel mediation analyses showed that greater time spent on the computer at T1 was not associated with higher *z*-BMI at T3 (total effect;

Table 2 Correlations between all main study variables

	1	2	3	4	5	6	7
1. Total screen time (T1)	–						
2. TV (T1)	0·72**	–					
3. Computer (T1)	0·74**	0·34***	–				
4. Video games (T1)	0·73**	0·31***	0·24***	–			
5. Restrained eating (T2)	–0·03	–0·007	0·07	–0·11**	–		
6. Emotional eating (T2)	0·21**	0·14***	0·20***	–0·06	0·37***	–	
7. *z*-BMI (T3)	0·25*	0·13*	0·04	0·08	0·31***	0·01	–

*$P < 0{\cdot}05$, **$P < 0{\cdot}01$, *** $P < 0{\cdot}001$.

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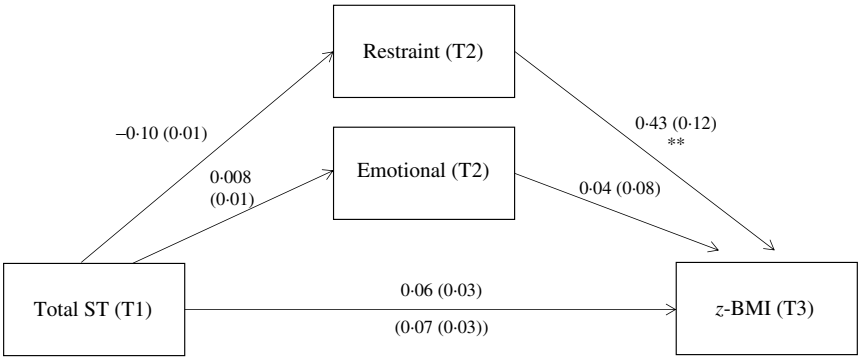

Fig. 1 Mediation analyses demonstrating the total (SE) and direct (SE) effects of total screen time on standardised BMI *z*-scores (*z*-BMI) through restrained and emotional eating, controlling for age, gender and socioeconomic status. Bias-corrected CI were calculated using 5000 bootstrapped samples. The coefficient for direct effect (SE) is shown in parentheses below the coefficient for total effect (SE). $^{*}P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$

Table 3 Total and specific indirect effects of screen time (ST) on *z*-BMI through disordered eating (restrained and emotional) presented with bias-corrected 95 % CI

			Bias-corrected 95 % CI	
	Parameter estimate	SE	Lower	Upper
Model 1: total ST				
Total indirect effect	–0·004	0·005	–0·02	0·005
Restrained eating	–0·004	0·005	–0·02	0·004
Emotional eating	0·00	0·001	–0·001	0·006
Model 2: TV				
Total indirect effect	–0·001	0·01	–0·03	0·02
Restrained eating	–0·002	0·01	–0·02	0·02
Emotional eating	0·001	0·004	–0·004	0·02
Model 3: computer				
Total indirect effect	–0·005	0·01	–0·03	0·01
Restrained eating	–0·007	0·01	–0·03	0·009
Emotional eating	0·002	0·004	–0·002	0·02
Model 4: video game				
Total indirect effect	–0·01	0·01	–0·06	0·23
Restrained eating	–0·01	0·01	–0·04	0·006
Emotional eating	–0·002	0·004	–0·02	0·002

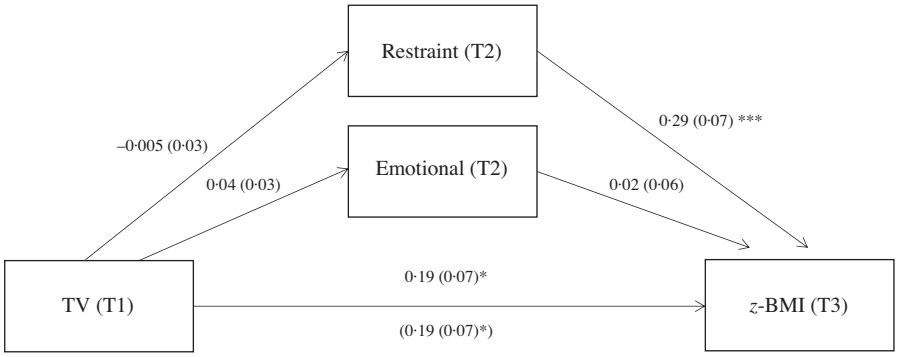

Fig. 2 Mediation analyses demonstrating the total (SE) and direct (SE) effects of TV on standardised BMI *z*-scores (*z*-BMI) through restrained and emotional eating, controlling for age, gender and socioeconomic status. Bias-corrected CI were calculated using 5000 bootstrapped samples. The coefficient for direct effect (SE) is shown in parentheses below the coefficient for total effect (SE). $^{*}P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$, $^{***}P < 0{\cdot}001$

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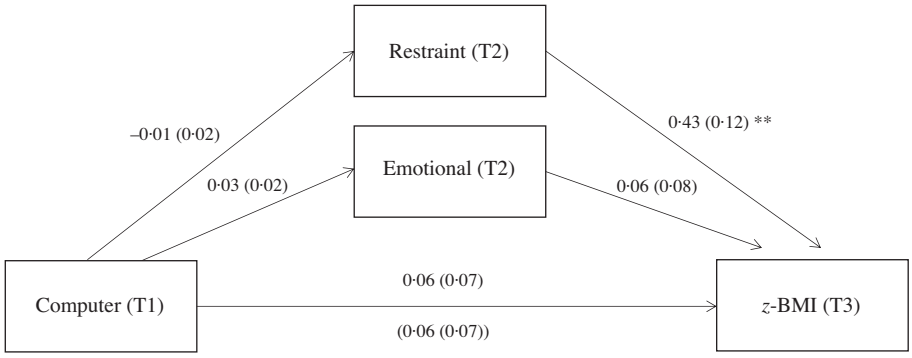

Fig. 3 Mediation analyses demonstrating the total (SE) and direct (SE) effects of computer use on standardised BMI *z*-scores (*z*-BMI) through restrained and emotional eating, controlling for age, gender and socioeconomic status. Bias-corrected CI were calculated using 5000 bootstrapped samples. The coefficient for direct effect (SE) is shown in parentheses below the coefficient for total effect (SE). $^{*}P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$, $^{***}P < 0{\cdot}001$

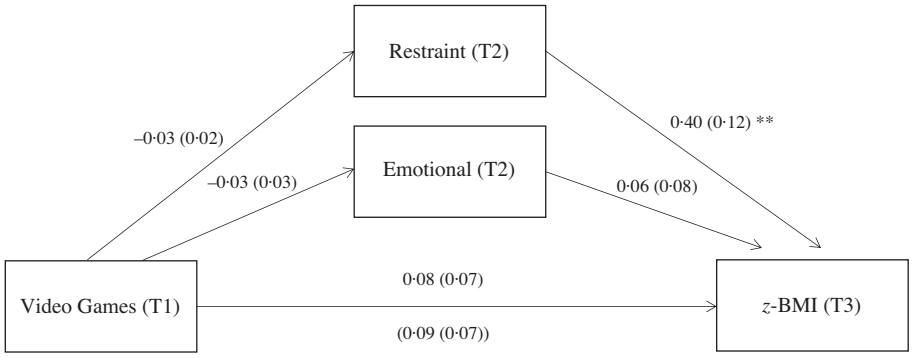

Fig. 4 Mediation analyses demonstrating the total (SE) and direct (SE) effects of video games on standardised BMI *z*-scores (*z*-BMI) through restrained and emotional eating, controlling for age, gender and socioeconomic status. Bias-corrected CI were calculated using 5000 bootstrapped samples. The coefficient for direct effect (SE) is shown in parentheses below the coefficient for total effect (SE). $^{*}P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$, $^{***}P < 0{\cdot}001$

$B = 0{\cdot}06$, SE = 0·07, $P = 0{\cdot}37$, 95 % CI –0·07, 0·19). Further, time spent on the computer at T1 was not associated with restrained or emotional eating at T2 (p's > 0·25). Only restrained eating at T2 was positively associated with *z*-BMI at T3 ($B = 0{\cdot}43$, SE = 0·12, $P < 0{\cdot}001$). Tests of total and specific indirect effects were non-significant, indicating no mediation had occurred (see Table 3).

Video games

As shown in Fig. 4, multiple parallel mediation analyses showed that greater time spent playing video games at T1 was non-significantly associated with higher *z*-BMI at T3 (total effect; $B = 0{\cdot}08$, SE = 0·07, $P = 0{\cdot}17$, 95 % CI –0·06, 0·23). Further, time spent playing video games at T1 was non-significantly associated with restrained or emotional eating at T2 (p's > 0·27). Only restrained eating at T2 was positively associated with *z*-BMI at T3 ($B = 0{\cdot}41$, SE = 0·142 $P = 0{\cdot}001$). Tests of total and specific indirect effects were non-significant, indicating no mediation had occurred (see Table 3).

Discussion

This study examined whether the longitudinal association between ST and *z*-BMI is mediated by disordered eating (restrained and emotional eating) in a large community-based sample of adolescents, and found a significant longitudinal association between TV viewing and *z*-BMI 2-years later. However, neither of the variables of disordered eating behaviour (restrained or emotional eating) significantly mediated this relationship. Moreover, neither total ST nor other types of ST (i.e. recreational computer use or video games) longitudinally predicted *z*-BMI.

Only few studies have examined different types of ST in association with *z*-BMI. We found that TV viewing is the only type of ST that predicted higher *z*-BMI in youth. Thus, our finding indicating a trend for borderline significant associations between total ST at baseline and higher *z*-BMI 2 years later appears to be driven by TV viewing and perhaps not an independent or cumulative impact of other forms of ST. This link between TV viewing and

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BMI aligns with previous studies documenting significant positive associations[16,21–26], but it is important to note that some studies did not show this association in either cross-sectional or longitudinal research in children and youth[23,24,52]. The mixed findings could be due, in part, to different sizes and characteristics of the samples, heterogeneity in measures used to quantify ST, differing durations of follow-up and varying data analytic techniques and covariates used in analyses. Future longitudinal research is needed to gain a better understanding of the association between different type of ST and *z*-BMI in children and youth.

To our knowledge, this is the first longitudinal investigation on the mediating role of disordered eating on the association between ST and BMI in youth. However, a recent cross-sectional study has found that energy intake mediated the relationship between ST and BMI in youth with obesity[34]. That is, ST is associated with greater energy intake, which, in turn, is associated with higher BMI. Similarly, research has also shown that many forms of ST, including TV and video gaming, acutely increase energy intake[35,36,65], with proposed mechanisms involving conditioning, distraction from hunger and satiety cues[37], and food-related advertisements and commercials[38]. Moreover, research using experimental designs to reduce ST has shown concomitant reductions in energy intake and adiposity[66,67]. These studies, combined with null mediation effects from the current study, provide compelling evidence that increased energy intake in the form of snacking or mindless eating[68] may be a central mechanism by which ST is associated with increased BMI, but the pattern of intake is not in the form of pathological eating styles such as emotional or restrained eating tested in the present study. Although the current study did not find any mediation effects, it still found a positive longitudinal association between restrained eating and *z*-BMI, consistent with many cross-sectional[49] and longitudinal studies[39,45–48].

It is possible that the null mediation effects could be due, in part, to the relatively short (2 years) duration of the study or the community-based, non-clinical sample characteristics, which may have limited variability in change scores in disordered eating needed to detect associations. Future research is required to verify our findings using a more extended study period. Also, further longitudinal studies are highly recommended to examine newer types of ST not included in this study, such as social media networking sites and online video games, as well as smartphone and tablet usage.

Our findings have important clinical implications for parents, educators, dietitians, physicians and other health practitioners who work with children and youth on health behaviours. ST, especially TV viewing, is a highly prevalent form of sedentary behaviour among youth with obesity, and in the present study it was longitudinally predictive of higher *z*-BMI, thus suggesting that youth who spend large amounts of time watching TV may be at an increased risk of developing their BMI. As such, our findings suggest that reducing TV viewing may be a beneficial strategy in the prevention of childhood obesity. Moreover, our findings support national guidelines in Canada and the United States[12,69] that recommend that children limit their recreational ST for optimal health and development.

Limitations of the study include the participation of youth who were primarily from mid-to-high SES backgrounds and conveniently sampled from only one geographic area in Canada, which may limit the generalisability of the study's findings to a national level. Further, this study began data collection before 2008 and ended in 2013. Thus, we could not capture more current forms of ST such as smartphone use, social media and multiplayer Internet gaming that are ubiquitous among adolescents and known to be associated with poorer physical and mental health[70,71]. Furthermore, we did not collect data on pubertal development, though we understand that pubertal development could have its impact on BMI trajectories and that age is a crude covariate. Thus, future research should collect data on pubertal development and control for its analyses. Despite these limitations, our study has several strengths. First, this study utilised a longitudinal design that included three time-points over 2 years. Second, this study is the first to assess the mediating effects of disordered eating on the association between ST and BMI in an adolescent population, and is the first to contribute data on the longitudinal association between ST and BMI in Canadian youth. We also measured BMI objectively, whereas most previous epidemiological samples relied on self-report, which is well known to yield biased estimates[33]. An additional strength is that we used standardised BMI in the analysis, rather than raw BMI, thereby correcting for growth and development in children, which only few previous longitudinal studies seemed to have adopted[27,28]. *z*-BMI provides an index of the age- and sex-matched rate of growth relative to the reference population longitudinally[72], and it has been recognised as an optimal measure of adiposity over time among children[73–75]. Finally, although the present study had some attrition, techniques for missing data estimation used in the present study showed statistical advantages over other techniques such as pairwise or listwise deletion[59].

Conclusion

At baseline, TV viewing was positively associated with *z*-BMI 2 years later, whereas computer use, video games and total ST were not longitudinally associated with *z*-BMI. However, despite identifying a significant association between restrained eating at T2 and *z*-BMI at T3 in the expected direction, neither disordered eating variables (restrained or emotional eating) mediated the association between TV viewing and *z*-BMI. This suggests that children

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and youth may overconsume food in response to screen exposure, resulting in weight gain and obesity[68], but the pattern of ingestion may not be considered disordered. Nevertheless, given the high prevalence of overweight and obesity, and the excessive time (i.e. 5–8 h/d) that youth spend in front of screens[76], interventions designed to reduce ST, most notably TV viewing, may be an effective strategy in the treatment and prevention of paediatric obesity. Further longitudinal studies with longer and more frequent follow-up evaluations are warranted to better understand the temporal associations between duration and type of modern forms of ST, eating behaviours and *z*-BMI, information that would optimally inform obesity prevention efforts.

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