A Canadian longitudinal study of the associations between weight control status and lifestyle behaviors during adolescence

Véronique Thibault [a,b,*], François Gallant [a,b], Karine Paiement [c], Stephanie Ward Chiasson [d], Simone Lemieux [e], Patrick Abi Nader [f], Mathieu Bélanger [a,b,g]

[a] *Faculté de médecine et des sciences de la santé, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1, Canada*
[b] *Centre de formation médicale du Nouveau-Brunswick, Moncton, New Brunswick E1A 7R1, Canada*
[c] *Faculté de médecine, Université de Montréal, Montréal, Québec H3T 1J4, Canada*
[d] *Faculté des sciences de la santé et des services communautaires, Université de Moncton, Moncton, New Brunswick E1A 3E9, Canada*
[e] *École de nutrition, Université Laval, Québec, Québec G1V 0A6, Canada*
[f] *Faculté des sciences de l'activité physique, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1, Canada*
[g] *Vitalité Health Network, Moncton, New Brunswick E1C 2Z3, Canada*

A B S T R A C T

This study aimed to estimate associations between weight control status (trying to lose, gain or maintain weight) and lifestyle behaviors (moderate-to-vigorous physical activity (MVPA), screen time, and the consumption of breakfast, fast food, fruits and vegetables, and sugar-sweetened beverages (SSB)) in adolescents.

Data from 919 adolescents in the MATCH study, in New Brunswick, Canada, who self-reported their weight control status at least once within 24 data collection cycles over 8 years (from 2011 to 2019) and from 812 who provided data at least once over the 7 cycles on eating behaviors were used. Generalized estimating equations were used.

At the first cycle, mean age was 11.3 (SD = 1.2) years old and 56% were girls. Trying to gain (β = 0.47, CI = [0.15, 0.79]) and maintain weight (β = 0.35, CI = [0.12, 0.57]) were positively associated with MVPA. Trying to lose weight was negatively associated with breakfast (IRR = 0.90, CI = [0.85, 0.94]) and positively associated with screen time (β = 0.62, CI = [0.15, 1.10]), fruit and vegetable (IRR = 1.12, CI = [1.01, 1.25]) and SSB (IRR = 1.42, CI = [1.10, 1.84]). Changes from one weight control status to trying to lose weight were associated with increases in fast food consumption (β = 0.49, CI = [0.15, 0.84]).

Weight control status was associated with healthy and unhealthy behaviors in adolescents. Trying to gain or maintain weight was generally associated with more favorable health-related behaviors. Education on healthy weight management behaviors is needed to improve adolescents' health.

1. Introduction

Despite efforts to reduce obesity among adolescents, its prevalence remains high (Janssen, 2013). Changes in lifestyle behaviors are recommended to promote healthy weights, including increasing the consumption of breakfast as well as fruits and vegetables, decreasing the consumption of fast food and sugar-sweetened beverages (SSB), increasing levels of moderate-to-vigorous physical activity (MVPA), and reducing leisure screen time (Weihrauch-Blüher et al., 2018). Half of adolescents intend to change their weight (Doan et al., 2021; Jeffery et al., 2013) and very few meet current healthy lifestyle recommendations (Gallant et al., 2020; Sampasa-Kanyinga et al., 2022; Banfield

et al., 2016). More information on factors that could influence healthy lifestyle behaviors is essential to improve weight management strategies to prevent overweight and obesity.

Based on the theory of planned behavior, intentions represent an important determinant of behavior (Bosnjak et al., 2020). According, having the intention or trying to change one's weight could potentially explain the development of healthy or unhealthy lifestyle behaviors in adolescents. Weight control status, including trying to lose, gain, or maintain weight (Rodgers et al., 2017) can lead to changes in lifestyle behaviors (Neumark-Sztainer et al., 2002). However, evidence suggests that weight control strategies do not always lead to the desired outcomes. For example, weight loss strategies, such as dieting, do not

---

necessarily lead to long-term weight loss (Field et al., 2010) and even lead to weight gain (Jeffery et al., 2013), psychological health problems (e.g., binge eating, body dissatisfaction, eating disorders, and low self-esteem), and increased feelings of culpability and stigmatization (Doan et al., 2021). Emerging weight management interventions promote a weight-neutral approach with a focus on health promotion rather than weight loss (Ulian et al., 2015; Wharton et al., 2020) and lead to better health (Golden et al., 2016). Considering that adolescents' weight and lifestyle behaviors are likely to be maintained into adulthood (Simmonds et al., 2016), it is important to better understand how weight control status influences adolescents' lifestyle to improve their health behaviors.

The use of weight control strategies is frequent among adolescents (Neumark-Sztainer et al., 2004) as more than half of girls and a third of boys report skipping meals, fasting, or smoking to control their weight (Neumark-Sztainer et al., 2004). However, cross-sectional studies have failed to find associations between adolescents' weight control status and healthy lifestyle behaviors, including physical activity (PA) and fruit and vegetable consumption (Kakinami et al., 2019; Fan and Jin, 2015). Similarly, the only longitudinal study on adolescents showed no links between weight control status and changes in levels of PA, screen time, consumption of fruits and vegetables, SSB, and fast food (Cai et al., 2018). In contrast, some longitudinal studies among adults, between one and three years of follow-up, have shown that trying to lose weight or maintain weight are positively associated with PA levels and fruit and vegetable consumption (Jeffery et al., 2013; Lee et al., 2004). These discrepancies suggest that more longitudinal studies with longer follow-up periods and more frequent assessments are needed to examine associations between adolescents' weight control status and lifestyle behaviors.

Given the aforementioned gaps in the literature, the objective of this study was to estimate the associations between weight control status and lifestyle behaviors, specifically MVPA, screen time, and eating behaviors (i.e., consumption of breakfast, fast food, fruits and vegetables, and SSB) during adolescence. To better understand potential associations, the research objective was approached from two perspectives. First, the average associations between weight control status and lifestyle behaviors were estimated. Second, the relationship between changes in weight control status and changes in lifestyle behaviors were assessed. Based on studies among adults, it was hypothesized that trying to lose or maintain weight would be associated with healthier lifestyle behaviors in adolescents, specifically higher MVPA, fruit and vegetable and breakfast consumption, as well as lower screen time and reduced consumption of fast food and SSB.

2. Methods

2.1. Study population and data source

This study used data from MATCH (Monitoring Activities of Teenagers to Comprehend their Habits), an ongoing longitudinal study of patterns of PA participation and other lifestyle behaviors from childhood to adulthood (Bélanger et al., 2013). A non-probability sample of 929 participants were recruited in grades 5 and 6 from 17 schools in New Brunswick, Canada. During the adolescent years, students answered a self-reported questionnaire three times annually (every four months) from 2011 to 2019 for a total of up to 24 cycles. For the first 13 cycles, research team members administered the paper-based questionnaires in school classes and subsequently in schools' computer room using the online Lime Survey platform. At every cycle, participants were reminded to answer as honestly as possible, that their responses remained confidential and that there were no right or wrong answers. Weight control status, MVPA and screen time were reported at every cycle and eating behaviors were reported once a year at seven survey cycles (cycles 5, 8, 11, 14, 17, 20, 23). The MATCH study and this secondary analysis were approved by the Research Ethics Review Board at the Centre hospitalier

universitaire de Sherbrooke (Québec, Canada). MATCH study participants provided written informed assent and written informed consent from their parents.

Weight control status. Weight control status was assessed at each survey cycle using the following question: "*What do you currently do about your weight?*" The four response options were: 1) "I am trying to lose weight," 2) "I am trying to stay the same weight," 3) "I am trying to gain weight," or 4) "I don't do anything about my weight" (Neumark-Sztainer et al., 2002). As this study's objective was related to taking actions regarding weight; three different dichotomous weight control status outcomes were computed at each cycle (Trying to lose weight – yes/no, Trying to gain weight – yes/no, and Trying to maintain weight – yes/no). This approach previously demonstrated concurrent validity as adolescents' responses matched their parents' responses in 82% of cases (Rosen and Poplawski, 1987).

MVPA. Following a definition of MVPA, participants reported the number of days in which they were involved in at least 60 min of MVPA 1) in the past 7 days, and 2) in a typical week. Response options were based on an 8-item scale (0 to 7 days). MVPA was estimated by computing the mean of the two items. This scale represents a reliable (test–retest with MATCH data [r = 0.79]) (Brunet et al., 2016) and valid (correlated with accelerometer-measured MVPA [r = 0.4]) tool to measure MVPA among adolescents (Prochaska et al., 2001).

Screen time. Average daily leisure screen time was estimated using three items related to screen use: 1) watching TV or movies; 2) using a computer, iPad, tablet (not for homework); and 3) playing video games (such as XBOX, Wii or PlayStation as well as iPad, iPod, cellular or tablet). Examples presented in these items were adapted or added to reflect technological advancements co-occurring with the study period. For each item, participants reported the number of hours spend in screen time during free time for 1) a normal weekday and 2) a normal weekend day. Response options were: 0 h, ½ hour, 1 h, 2 h, 3 h, 4 h, and 5+ hours. As recommended in the original version of this tool, average daily screen time was calculated as: [(5*sum of responses on weekdays) + (2*sum of responses on weekends)]/7 (Utter et al., 2003). A confirmatory factor analysis confirmed the relevance of the three items in this modified scale (Gunnell et al., 2018) and an invariance analysis confirmed it was appropriate for use in longitudinal assessments (Gunnell et al., 2018).

Eating behaviors. Eating behaviors were assessed based on the Youth Risk Behavior Surveillance System (YRBSS) dietary questionnaire (Eaton et al., 2013; Brener et al., 2013; Gunnell et al., 2018) which has good test–retest reliability (kappa ≥ 0.61) (Brener et al., 2013). Participants reported weekly consumption from the past seven days of breakfast and fast-food, using an 8-point scale ranging from 0 days to 7 days. Fruit and vegetable and SSB consumption were reported as daily frequency in the last seven days. Fruit and vegetable consumption included the sum of five items: fruits, green salad, potatoes (excluding fried potatoes and chips), carrots, and other vegetables. SSB consumption included the sum of four beverage items with added sugars (soda drinks, sugar-sweetened beverages, energy drinks, and sports drinks) and did not include 100% fruit juices. Response options to the items "I haven't eaten or drank it in the last 7 days," were: "1 to 3 times in the last 7 days," "4 to 6 times in the last 7 days," "1 time/day," "2 times/day," "3 times/day," "≥4 times/day." To calculate daily frequency, "1–3 times per week" was considered as 0.29 time per day, and "4–6 times per week" was considered as 0.71 time per day, which is a calculation method that has been used previously (Eaton et al., 2013; Doggui et al., 2021).

Covariables. Potential confounders, including gender, body mass index (BMI), puberty status, and socioeconomic status (SES) were adjusted for in the models. Gender included choices of "boy", "girl" or "other" (the "other" category was not retained since it represented less than 1% of total responses). Self-reported BMI (kg/m^2) was measured by dividing the self-reported weight (kg) by height (meters) squared. Puberty was estimated from the self-reported Pubertal Development Scale, which demonstrated acceptable psychometric properties (Shirtcliff

et al., 2009) and allows the calculation of five pubertal stages from prepubertal to postpubertal. SES was represented by tertiles of neighborhood income. This was done by matching participants' postal code to the mean income of persons ≥ 15 years in their neighbourhood, which was obtained from Statistic Canada's 2011 National Household Survey (Canada, 2011).

2.2. Statistical analyses

Analyses included data from all cycles where both weight control status and lifestyle behaviors were measured (24 cycles for MVPA and screen time, and 7 cycles for eating behaviors). Descriptive analyses (mean and standard deviation [SD] or number and proportions [%]) were performed for the first cycle when the following variables were available (cycle 1: weight control status, MVPA, screen time, puberty status, and SES; cycle 5: eating behaviors; and cycle 11: BMI) (Table 1). A description of lifestyle behaviors at every cycle is available in Additional file 1. For each variable, missing data accounted for 10% or less of cases and were not replaced as they did not satisfy the assumption of missing at random (Sterne et al., 2009).

To estimate the average associations between weight control status and lifestyle behaviors throughout adolescence, generalized estimating equations (GEE), that accounted for repeated measures, were used. MVPA and screen time were modeled using a normal distribution and a Poisson distribution was used for eating behavior variables.

To assess whether changes in weight control status were associated with changes in lifestyle behaviors, the GEE models included the changes in both variables. Specifically, change in weight control status was considered as the change from any weight control status to another

between the previous cycle and the current one. Change in lifestyle behaviors were computed as the difference between the previous cycle and the current cycle. Exchangeable working correlation was used for all models, as it was the most appropriate compared to other correlation matrices (AR1, and unstructured) based on the lowest quasi-likelihood under independence model criterion (QIC) (Pan, 2001). All analyses were adjusted for covariables presented above. Analyses were conducted using R 4.2.0 with the GEE package (Carey, 2022) and were not stratified by gender since the interaction between gender and weight control status was not statistically significant.

3. Results

A total of 919 participants provided data related to weight control status, MVPA and screen time at least once, and were retained for analysis. These participants took part in a median of 13 (interquartile range (IQR =[8–19]) survey cycles during adolescence. A total of 812 participants provided data on eating behaviors at least once, took part in a median of three (IQR=[2–5]) survey cycles and were retained for analysis.

3.1. Participant characteristics

At their first cycle of participation, participants were, on average, 11.3 (SD = 1.2) years old and 56% were girls (Table 1). A third of the sample reported trying to lose weight, another third reported trying to maintain weight, a quarter were not doing anything about their weight and 5% tried to gain weight. The proportion reporting different weight control statuses was similar between boys and girls except that more boys reported trying to gain weight than girls (7.5% vs. 3.7%, respectively; p = 0.01, data not shown). Participants reported taking part in at least 60 min of MVPA less than five days a week and spent close to four hours daily using screens for leisure. The first time eating behaviors were measured, participants reported approximately consuming breakfast six days a week, fast food one day a week, fruits and vegetables six times a day and drinking SSB twice a day.

3.2. Associations between weight control status and lifestyle behaviors during adolescence

Trying to lose weight was not associated with MVPA, or fast food consumption during adolescence (Table 2). However, trying to lose weight was negatively associated with breakfast consumption (incidence rate ratio (IRR) = 0.90, CI = [0.85,0.94]) and positively associated with daily leisure screen time (β = 0.62, CI = [0.15,1.10]), consuming fruits and vegetables (IRR = 1.12, CI = [1.01,1.25]) and SSB (IRR = 1.42, CI = [1.10,1.84]) (Table 3).

Trying to gain weight was positively associated with MVPA during adolescence (β = 0.47, CI = [0.15,0.79]), but not with daily leisure screen time (Table 2). Trying to gain weight was also positively

Table 1
Sociodemographic characteristics, weight control status, and lifestyle behaviors of Canadian adolescents when they were first participated in the MATCH study (n (%) or mean (SD)).

	n (%) or mean (SD)
Sociodemographic characteristics	
Sex (girls), n (%) (n = 919)	510 (55.5)
Age (year), mean (SD) (n = 919)	11.3 (1.2)
BMI (kg/m^2), mean (SD) (n = 566)	20.6 (3.9)
Puberty stage (category), n (%) (n = 899)	
Prepubertal	181 (20.1)
Early pubertal	244 (27.1)
Midpubertal	180 (20.0)
Late pubertal	285 (31.7)
Postpubertal	9 (1.0)
SES (income), n (%) (n = 919)	
High ($34414–$57098)	254 (27.6)
Medium ($27698–$34165)	327 (35.6)
Low ($15487–$27582)	338 (36.8)
Weight control status, n (%) (n = 919)	
Trying to lose weight (yes)	313 (34.1)
Trying to gain weight (yes)	50 (5.4)
Trying to maintain weight (yes)	302 (32.9)
Doing nothing about weight (yes)	254 (27.6)
Lifestyle behaviors, mean (SD)	
MVPA (day/wk) (n = 906)	4.4 (1.8)
Screen time (hr/day) (n = 916)	3.5 (2.7)
Breakfast (freq/wk) (n = 812)	5.5 (2.2)
Fast food (freq/wk) (n = 812)	0.9 (1.3)
Fruits and vegetables (freq/day) (n = 810)	5.5 (4.2)
SSB (freq/day) (n = 808)	1.5 (2.5)

MATCH = Monitoring Activities of Teenagers to Comprehend their Habits; BMI = body mass index; SES = socioeconomic status; MVPA = moderate-to-vigorous physical activity; day/wk = days per week; hr/day = hours per day; freq/wk = frequency per week; freq/day = frequency per day, SSB = sugar-sweetened beverages.

Table 2
Standardized Beta and 95% confidence intervals (CI) of the average associations of weight control status with MVPA and screen time in Canadian adolescents (MATCH study, 2011 to 2019).

	MVPA*		Screen time *	
	β	95% CI	β	95% CI
Time	**−0.07**	**[−0.09,−0.04]**	**−0.08**	**[−0.13,−0.03]**
Trying to lose weight	0.13	[−0.11,0.37]	**0.62**	**[0.15,1.10]**
Trying to gain weight	**0.47**	**[0.15,0.79]**	−0.33	[−0.91,0.24]
Maintain weight	**0.35**	**[0.12,0.57]**	−0.10	[−0.54,0.34]

*Models were adjusted for gender, socioeconomic status, puberty and body mass index.
MATCH = Monitoring Activities of Teenagers to Comprehend their Habits; MVPA = moderate-to-vigorous physical activity.

Table 3

Incidence rate ratio (IRR) and 95% confidence intervals (CI) of the average associations between weight control status and eating habits in Canadian adolescents (MATCH study, 2012 to 2019).

	Breakfast*		Fast food*		Fruits and vegetables*		SSB*	
	IRR	95 %CI	IRR	95 %CI	IRR	95 %CI	IRR	95 %CI
Time	1.00	**[1.00,1.01]**	1.01	[1.00,1.02]	0.98	**[0.97,0.99]**	0.94	**[0.91,0.97]**
Trying to lose weight	**0.90**	**[0.85,0.94]**	1.09	[0.98,1.20]	**1.12**	**[1.01,1.25]**	**1.42**	**[1.10,1.84]**
Trying to gain weight	1.00	[0.94,1.07]	1.07	[0.95,1.21]	**1.17**	**[1.02,1.34]**	1.33	[0.99,1.80]
Maintain weight	1.02	[0.98,1.07]	1.06	[0.97,1.17]	1.07	[0.96,1.19]	1.20	[0.93,1.55]

*Models were adjusted for gender, socioeconomic status, puberty and body mass index.
MATCH = Monitoring Activities of Teenagers to Comprehend their Habits; SSB = sugar-sweetened beverages.

associated with fruit and vegetable (IRR = 1.17, CI = [1.02,1.34]), but not with breakfast, fast food or SSB consumption.

Trying to maintain weight was also positively associated with MVPA (β = 0.35, CI = [0.12,0.57]), but not with daily leisure screen time (Table 2) or any eating behaviors (Table 3).

3.3. Associations between changes in weight control status and changes in lifestyle behaviors

Participants who changed their weight control status to trying to lose weight generally reported a concurrent increase in fast food consumption (Table 4). No association was found between changes in trying to gain weight or trying to maintain weight and changes in lifestyle behaviors.

4. Discussion

This study aimed to understand associations between weight control status and lifestyle behaviors during adolescence. Based on the theory of planned behavior, weight control status, such as trying to lose, to gain or to maintain weight, might explain the development of healthy or unhealthy lifestyle behaviors in adolescents. It was expected that adolescents trying to lose weight would be more health conscious and would therefore adopt healthier lifestyle behaviors. However, this study showed that trying to lose weight was associated with both healthy and unhealthy lifestyle behaviors. In fact, participants who reported trying to lose weight also reported higher leisure screen time and intake of SSB, and lower frequency of breakfast consumption. Nevertheless, they reported a greater consumption of fruits and vegetables. Adolescents who reported trying to gain weight or maintain weight generally presented more favorable lifestyle behaviors than adolescents trying to lose weight.

Trying to lose weight was not associated with MVPA which is similar to cross-sectional studies conducted among adolescents (Kakinami et al., 2019; Fan and Jin, 2015). However, our results differ from findings among adults (Jeffery et al., 2013), while trying to lose weight was associated with higher MVPA and lower screen time. In this analysis, it is possible that adolescents participated in PA, but not at moderate or

vigorous levels, or they did not reach the minimum daily 60 min captured by the measurement tool. It is also possible that adults who express trying to lose weight are more conscious than adolescents of the favorable behaviors to adopt to achieve this goal healthily. It is also possible that because a large proportion of adolescents' time is spent in schools, which represents a controlled environment, there is less between-individual variability in behaviors which would reduce the likelihood of identifying significant associations. The association between daily leisure screen time and trying to lose weight might also be explained by a reverse causation association as more sedentary people might have gained weight (Smith et al., 2017) which influences them to try to lose weight.

In addition, participants who reported trying to lose weight generally reported more SSB intake. This finding is counter-intuitive, considering that reducing SSB intake is one of the most common behavioral targets of large-scale obesity prevention programs (Kite et al., 2018). In fact, SSB contributes to higher energy intake, provides little satiety, and can lead to weight gain and obesity (Brown et al., 2015). These findings might be explained by a reverse causation association as people who are consuming more SSB may experience more weight gain, which, in turn, could influence them to try to lose weight. This would be consistent with findings from the individual change analyses which showed that people who change their weight control status to trying to lose weight did not increase their consumption of SSB.

Trying to lose weight was associated with lower breakfast consumption. Skipping meals is a frequent weight control behavior among adolescents (Neumark-Sztainer et al., 2004) and is not a healthy weight management strategy since it is associated with increased caloric intake at the next meal and lower overall diet quality (Zeballos and Todd, 2020). In contrast, this analysis shows that trying to lose weight was associated with greater fruit and vegetable consumption which is consistent with studies among adults (Jeffery et al., 2013). While some studies in adolescents found no association between trying to lose weight and meeting fruit and vegetable consumption recommendations (Cai et al., 2018; Fan and Jin, 2015), Kakinami (2019) found that adolescents with obesity who were trying to lose weight were more likely to meet fruit and vegetable recommendations than those who were not trying to lose weight (Kakinami et al., 2019). Increase in fruit and

Table 4

Standardized Beta and 95% confidence intervals (CI) of the associations between changes in weight control status and changes in lifestyle behaviors in Canadian adolescents (MATCH study, 2012 to 2019).

	MVPA*		Screen time*		Fruits and vegetables*		SSB*		Breakfast*		Fast food*	
Weight control status change to	β	95 %CI	β	95 %CI	β	95 %CI	β	95 %CI	β	95 %CI	β	95 %CI
Trying to lose weight	0.18	[−0.14,0.49]	0.19	[−0.34,0.73]	−0.45	[−1.37,0.47]	−0.39	[−0.98,0.21]	0.12	[−0.32,0.56]	**0.49**	**[0.15,0.84]**
Trying to gain weight	0.05	[−0.35,0.45]	0.08	[−0.60,0.75]	0.01	[−1.20,1.23]	−0.60	[−1.41,0.20]	0.33	[−0.25,0.90]	0.03	[−0.43,0.48]
Maintain weight	−0.02	[−0.29,0.26]	−0.11	[−0.59,0.37]	−0.15	[−1.10,0.79]	−0.05	[−0.68,0.59]	−0.10	[−0.54,0.34]	−0.21	[−0.57,0.15]

*Models are adjusted for gender, SES, puberty and BMI.
MATCH = Monitoring Activities of Teenagers to Comprehend their Habits; MVPA = moderate-to-vigorous physical activity; SSB = sugar-sweetened beverages.

vegetable consumption has been presented as a massive public health strategy to improve health and to control weight in adolescents (Brown et al., 2016).

When investigating changes in weight control status, adolescents who changed their weight control status to trying to lose weight reported increases in fast food consumption. This is another counter-intuitive finding that could be explained by reverse causation or by limitations in measurement tools. These participants may have experienced weight gain that motivated them to change their weight. In fact, consumption of fast food has been associated with weight gain and obesity (Brown et al., 2015). Participants may have increased their fast food consumption that make them want to change their weight. Another hypothesis might be related to eating disinhibition or restraint in context of weight control, which can lead to loss of control and binge eating episodes (Teixeira et al., 2005). A study among young women did not find an association between trying to lose weight and fast food consumption but documented that only 28% of participants trying to lose or maintain their weight avoided high-fat or high-energy foods as a weight management strategy (Tanenbaum et al., 2016).

In contrast to those trying to lose weight, adolescents trying to gain weight generally reported healthier lifestyle behaviors. Trying to gain weight was associated, on average, with higher MVPA and greater fruit and vegetable consumption. Trying to gain weight is less reported in studies but warrants greater interest considering that some adolescents, mostly boys, are likely to try to gain weight (Minnick et al., 2020). In the MATCH study, boys were more likely than girls to report trying to gain weight. In addition, while the item used to capture weight gain in this study did not specify gains in muscularity, idealization of muscularity or the perception of being underweight may lead to weight gain strategies, such as eating more overall or more protein, and exercising (Minnick et al., 2020). A study showed that more than 90% of adolescent boys used exercise to increase their muscle mass (Eisenberg et al., 2012). Since young people who aim to gain weight generally eat more food (Minnick et al., 2020), it is encouraging that they seem to consume more fruits and vegetables.

Trying to maintain weight was associated with higher MVPA, which is consistent with other studies. Kruger et al. (2007) showed that adults trying to maintain their weight were three times more likely to be regularly active compared to people with no weight control intentions (Kruger et al., 2007). However, this study did not find an association with total screen time, which is contrary to Jeffery et al.'s (2013), which found an association between the intention to avoid weight gain and less screen time (Jeffery et al., 2013). Our data did not reveal any association between trying to maintain weight and any eating behaviors. This might suggest that people who feel they are at their desired weight do not see any incentive to make dietary changes. However, one study showed that women avoiding weight gain consume less fast food and soft drinks and more fruits and breakfast cereals (Jeffery et al., 2013).

Taken together, the results of this study suggest a pressing need for more education to improve lifestyle behaviors around weight control management among adolescents. This is especially true when it has been estimated that more than 60% of Canadians believe that improvements in eating behaviors or PA are not effective strategies for long-term weight management (Sharma et al., 2019). This study is the first to investigate the longitudinal association between weight control status and various recommended weight control behaviors (i.e., MVPA, screen time, and eating behaviors such as fruit and vegetable, fast food, SSB, and breakfast) in adolescents. As such, this study provides valuable insights on weight control status and lifestyle behaviors of adolescents among the general population as these indicators were not measured in the context of a weight management intervention. To better inform interventions, future studies should nevertheless investigate what contributes to the adoption of healthy behaviors among adolescents who desire to control their weight. Potential factors to consider may include parental and peer support, education and environmental characteristics.

Strengths of this study include the frequent administration of questionnaires and use of measures that assess behaviors over the past week rather than longer periods. This helps minimize the risk of recall bias. Nevertheless, one limitation is the possibility of social desirability bias associated with self-report questionnaires. Another limit is that we did not capture information specific to weight management strategies, such as excessive training, fasting, and skipping meals, which could have helped explain associations investigated herein. While our measure of eating behaviors may be more susceptible to measurement error than multiple 24-hour dietary interviews or food diaries (Eaton et al., 2013), it allowed us to document trends in multiple eating habits (e.g., fruits and vegetables, fast food, SSB, and breakfast) that are included in obesity prevention guidelines for youth (Weihrauch-Blüher et al., 2018). Future studies should incorporate more detailed descriptions of participants' eating behaviors, including dieting patterns, to improve our knowledge of associations between weight control status and lifestyle behaviors.

5. Conclusions

This study highlights that the weight control status of adolescents is associated with the adoption of both healthy and unhealthy lifestyle behaviors. Considering that adolescents who are trying to lose weight represent a large proportion of the population and that they report a higher prevalence of unhealthy behaviors, more education is needed to increase awareness of the benefits of increasing MVPA, reducing sedentary time and improving eating behaviors to manage their weight healthily and improve their overall health.

6. Financial disclosure

CRediT authorship contribution statement

Véronique Thibault: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **François Gallant:** Conceptualization, Data curation, Writing – review & editing. **Karine Paiement:** Conceptualization, Writing – review & editing. **Stephanie Ward Chiasson:** Conceptualization, Writing – review & editing. **Simone Lemieux:** Conceptualization, Writing – review & editing. **Patrick Abi Nader:** Conceptualization, Writing – review & editing. **Mathieu Bélanger:** Supervision, Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102498.

References

Banfield, E.C., Liu, Y., Davis, J.S., Chang, S., Frazier-Wood, A.C., 2016. Poor adherence to US Dietary Guidelines for Children and Adolescents in the National Health and Nutrition Examination Survey Population. J. Acad. Nutr. Diet. 116, 21–27. https://doi.org/10.1016/j.jand.2015.08.010.

Bélanger, M., Caissie, I., Beauchamp, J., Loughlin, J.O., Sabiston, C., Mancuso, M., 2013. Monitoring activities of teenagers to comprehend their habits: study protocol for a mixed-methods cohort study. BMC Public Healh. 13, 649.

Bosnjak, M., Ajzen, I., Schmidt, P., 2020. The theory of planned behavior: Selected recent advances and applications. Eur. J. Psychol. 16, 352–356. https://doi.org/10.5964/ejop.v16i3.3107.

Brener, N.D., Kann, L., Shanklin, S., Kinchen, S., Eaton, D.K., Hawkins, J., Flint, K.H., 2013. Methodology of the youth risk behavior surveillance system - 2013. MMWR Recommend. Reports 62, 1–23.

Brown, C.L., Halvorson, E.E., Cohen, G.M., Lazorick, S., Skelton, J.A., 2015. Addressing childhood obesity. Opportunities for prevention. Pediatr. Clin. North Am. 62, 1241–1261. https://doi.org/10.1016/j.pcl.2015.05.013.

Brown, C.L., Skelton, J.A., Perrin, E.M., Skinner, A.C., 2016. Behaviors and motivations for weight loss in children and adolescents. Obesity 24, 446–452. https://doi.org/10.1002/oby.21370.

Brunet, J., Gunnell, K.E., Teixeira, P., Sabiston, C.M., Bélanger, M., 2016. Should we be looking at the forest or the trees? Overall psychological need satisfaction and individual needs as predictors of physical activity. J. Sport Exerc. Psychol. 38, 317–330. https://doi.org/10.1123/jsep.2016-0256.

Cai, L., Dai, M., Lin, L., Yang, W., Chen, Y., Ma, J., Jing, J., 2018. Incidence of childhood overweight and obesity and its association with weight-related attitudes and behaviors in China: a national longitudinal study. Int. J. Behav. Nutr. Phys. Act. 15, 108. https://doi.org/10.1186/s12966-018-0737-6.

Carey, J.V. 2022. Generalized Estimation Equation Solver - Package gee.

Doan, N., Romano, I., Butler, A., Laxer, R.E., Patte, K.A., Leatherdale, S.T. 2021. Weight control intentions and mental health among Canadian adolescents: A gender-based analysis of students in the compass study, Health Prom. Chron. Dis. Prev. Canada. 41, 119–130. 10.24095/HPCDP.41.4.01.

Doggui, R., Ward, S., Johnson, C., Bélanger, M., 2021. Trajectories of eating behaviour changes during adolescence. Nutrients 13. https://doi.org/10.3390/nu13041313.

Eaton, D.K., Olsen, E.O.M., Brener, N.D., Scanlon, K.S., Kim, S.A., Demissie, Z., Yaroch, A.L., 2013. A comparison of fruit and vegetable intake estimates from three survey question sets to estimates from 24-hour dietary recall interviews. J. Acad. Nutr. Diet. 113, 1165–1174. https://doi.org/10.1016/j.jand.2013.05.013.

Eisenberg, M.E., Wall, M., Neumark-Sztainer, D., 2012. Muscle-enhancing behaviors among adolescent girls and boys. Pediatrics 130, 1019–1026. https://doi.org/10.1542/peds.2012-0095.

Fan, M., Jin, Y., 2015. The effects of weight perception on adolescents' weight-loss intentions and behaviors: evidence from the youth risk behavior surveillance survey. Int. J. Environ. Res. Public Health 12, 14640–14668. https://doi.org/10.3390/ijerph121114640.

Field, A.E., Haines, J., Rosner, B., Willett, W.C., 2010. Weight-control behaviors and subsequent weight change among adolescents and young adult females. Am. J. Clin. Nutr. 91, 147–153. https://doi.org/10.3945/ajcn.2009.28321.

Gallant, F., Thibault, V., Hebert, J., Gunnell, K.E., Bélanger, M., 2020. One size does not fit all: Identifying clusters of physical activity, screen time, and sleep behaviour co-development from childhood to adolescence. Int. J. Behav. Nutr. Phys. Act. 17 https://doi.org/10.1186/s12966-020-00964-1.

Golden, N.H., Schneider, M., Wood, C., Daniels, S., Abrams, S., Corkins, M., de Ferranti, S., Magge, S.N., Schwarzenberg, S., Critch, J., Hubbard, V., Scanlon, K., Soto, V., Burrowes, D., Haro, T., Braverman, P.K., Adelman, W., Alderman, E.M., Breuner, C.C., Levine, D.A., Marcell, A.V., O`Brien, R., Lane, M., Strickland, J., Shain, B., Smith, K., Baumberger, J., Pont, S., Bolling, C., Cook, S., Liu, L., Robert, S., Slusser, W., Thapar, M., Lindros, J., 2016. Preventing obesity and eating disorders in adolescents. Pediatrics 138. https://doi.org/10.1542/peds.2016-1649.

Gunnell, K.E., Brunet, J., Bélanger, M., 2018. Out with the old, in with the new: Assessing change in screen time when measurement changes over time. Prev. Med. Rep. 9, 37–41. https://doi.org/10.1016/j.pmedr.2017.12.008.

Janssen, I., 2013. The public health burden of obesity in Canada. Can. J. Diabetes 37, 90–96. https://doi.org/10.1016/j.jcjd.2013.02.059.

Jeffery, R.W., Abbott, G., Ball, K., Crawford, D., 2013. Behavior and weight correlates of weight-control efforts in Australian women living in disadvantage: The READI study. Int. J. Behav. Nutr. Phys. Act. 10, 52. https://doi.org/10.1186/1479-5868-10-52.

Kakinami, L., Houle-Johnson, S.A., Demissie, Z., Santosa, S., Fulton, J.E., 2019. Meeting fruit and vegetable consumption and physical activity recommendations among adolescents intending to lose weight. Prev. Med. Rep. 13, 11–15. https://doi.org/10.1016/j.pmedr.2018.10.021.

Kite, J., Grunseit, A., Bohn-Goldbaum, E., Bellew, B., Carroll, T., Bauman, A., 2018. A systematic search and review of adult-targeted overweight and obesity prevention mass media campaigns and their evaluation: 2000–2017. J. Health Commun. 23, 207–232. https://doi.org/10.1080/10810730.2018.1423651.

Kruger, J., Yore, M.M., Kohl 3rd, H.W., 2007. Leisure-time physical activity patterns by weight control status: 1999–2002 NHANES. Med. Sci. Sports Exerc. 39, 788–795. https://doi.org/10.1249/mss.0b013e3180333efc.

Lee, J.S., Kritchevsky, S.B., Tylavsky, F.A., Harris, T., Everhart, J., Simonsick, E.M., Rubin, S.M., Newman, A.B., 2004. Weight-loss intention in the well-functioning, community-dwelling elderly: associations with diet quality, physical activity, and

weight change. Am. J. Clin. Nutr. 80, 466–474. https://doi.org/10.1093/ajcn/80.2.466.

Minnick, C., Raffoul, A., Hammond, D., Kirkpatrick, S.I., 2020. Intentional weight gain efforts among young Canadian adults aged 17–32 years. Eat. Behav. 38 https://doi.org/10.1016/j.eatbeh.2020.101407.

Neumark-Sztainer, D., Story, M., Hannan, P.J., Perry, C.L., Irving, L.M., 2002. Weight-related concerns and behaviors among overweight and nonoverweight adolescents. Arch. Pediatr. Adolesc. Med. 156, 171–178.

Neumark-Sztainer, D., Hannan, P.J., Story, M., Perry, C.L., 2004. Weight-control behaviors among adolescent girls and boys: implications for dietary intake. J. Am. Diet. Assoc. 104, 913–920. https://doi.org/10.1016/j.jada.2004.03.021.

Pan, W., 2001. Akaike's information criterion in generalized estimating equations. Biometrics 57 (1), 120–125. https://doi.org/10.1111/j.0006-341x.2001.00120.x.

Prochaska, J.J., Sallis, J.F., Long, B., 2001. A physical activity screening measure for use with adolescents in primary care. Arch. Pediatr. Adolesc. Med. 155, 554–559. https://doi.org/10.1001/archpedi.155.5.554.

Rodgers, R.F., Peterson, K.E., Hunt, A.T., Spadano-Gasbarro, J.L., Richmond, T.K., Greaney, M.L., Bryn Austin, S., 2017. Racial/ethnic and weight status disparities in dieting and disordered weight control behaviors among early adolescents. Eat. Behav. 26, 104–107. https://doi.org/10.1016/j.eatbeh.2017.02.005.

Rosen, J.C., Poplawski, D., 1987. The validity of self-reported weight loss and weight gain efforts in adolescents. Int. J. Eat. Disord. 6, 515–523. https://doi.org/10.1002/1098-108X(198707)6:4<515::AID-EAT2260060408>3.0.CO;2-Z.

Sampasa-Kanyinga, H., Lien, A., Hamilton, H.A., Chaput, J.P., 2022. The Canadian 24-hour movement guidelines and self-rated physical and mental health among adolescents. Can. J. Public Health 113, 312–321. https://doi.org/10.17269/s41997-021-00568-7.

Sharma, A.M., Bélanger, A., Carson, V., Krah, J., Langlois, M., Lawlor, D., Lepage, S., Liu, A., Macklin, D.A., MacKay, N., Pakseresht, A., Pedersen, S.D., Ramos Salas, X., Vallis, M., 2019. Perceptions of barriers to effective obesity management in Canada: Results from the ACTION study. Clin. Obes. 9 https://doi.org/10.1111/cob.12329.

Shirtcliff, E.A., Dahl, R.E., Pollak, S.D., 2009. Pubertal development: Correspondence between hormonal and physical development. Child Dev. 80, 327–337. https://doi.org/10.1111/j.1467-8624.2009.01263.x.

Simmonds, M., Llewellyn, A., Owen, C.G., Woolacott, N., 2016. Predicting adult obesity from childhood obesity: A systematic review and meta-analysis. Obes. Rev. 17, 95–107. https://doi.org/10.1111/obr.12334.

Smith, K.J., Gall, S.L., McNaughton, S.A., Cleland, V.J., Otahal, P., Dwyer, T., Venn, A.J., 2017. Lifestyle behaviours associated with 5-year weight gain in a prospective cohort of Australian adults aged 26–36 years at baseline. BMC Public Health 17. https://doi.org/10.1186/s12889-016-3931-y.

Statistique Canada, Enquête nationale auprès des ménages (ENM), (2011).

Sterne, J.A.C., White, I.R., Carlin, J.B., Spratt, M., Royston, P., Kenward, M.G., Wood, A. M., Carpenter, J.R., 2009. Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. BMJ (Online) 339, 157–160. https://doi.org/10.1136/bmj.b2393.

Tanenbaum, H.C., Felicitas, J.Q., Li, Y., Tobias, M., Chou, C.-P., Palmer, P.H., Spruijt-Metz, D., Reynolds, K.D., Anderson Johnson, C., Xie, B., 2016. Overweight perception: Associations with weight control goals, attempts, and practices among Chinese Female College Students. J. Acad. Nutr. Diet. 116, 458–466. https://doi.org/10.1016/j.jand.2015.06.383.

Teixeira, P.J., Going, S.B., Sardinha, L.B., Lohman, T.G., 2005. A review of psychosocial pre-treatment predictors of weight control. Obes. Rev. 6, 43–65. https://doi.org/10.1111/j.1467-789X.2005.00166.x.

Ulian, M.D., Benatti, F.B., de Campos-Ferraz, P.L., Roble, O.J., Unsain, R.F., de Morais Sato, P., Brito, B.C., Murakawa, K.A., Modesto, B.T., Aburad, L., Bertuzzi, R., Lancha, A.H., Gualano, B., Scagliusi, F.B., 2015. The effects of a "Health at Every Size®"-Based Approach in Obese Women: A Pilot-Trial of the "Health and Wellness in Obesity" study. Front. Nutr. 2 https://doi.org/10.3389/fnut.2015.00034.

Utter, J., Neumark-Sztainer, D., Jeffery, R., Story, M., 2003. Couch potatoes or French fries: Are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? J. Am. Diet. Assoc. 103, 1298–1305. https://doi.org/10.1016/S0002-8223(03)01079-4.

Weihrauch-Blüher, S., Kromeyer-Hauschild, K., Graf, C., Widhalm, K., Korsten-Reck, U., Jödicke, B., Markert, J., Müller, M.J., Moss, A., Wabitsch, M., Wiegand, S., 2018. Current guidelines for obesity prevention in childhood and adolescence. Obes. Facts 11, 263–276. https://doi.org/10.1159/000486512.

Wharton, S., Lau, D.C.W., Vallis, M., Sharma, A.M., Biertho, L., Campbell-Scherer, D., Adamo, K., Alberga, A., Bell, R., Boulé, N., Boyling, E., Brown, J., Calam, B., Clarke, L., Crowshoe, L., Divalentino, D., Forhan, M., Freedhoff, Y., Gagner, M., Glazer, S., Grand, C., Green, M., Hahn, M., Hawa, R., Henderson, R., Hong, D., Hung, P., Janssen, I., Jacklin, K., Johnson-Stoklossa, C., Kemp, A., Kirk, S., Kuk, J., Langlois, M.F., Lear, S., McInnes, A., Macklin, D., Naji, L., Manjoo, P., Morin, M.P., Nerenberg, K., Patton, I., Pedersen, S., Pereira, L., Piccinini-Vallis, H., Poddar, M., Poirier, P., Prud'homme, D., Ramos Salas, X., Rueda-Clausen, C., Russell-Mayhew, S., Shiau, J., Sherifali, D., Sievenpiper, J., Sockalingam, S., Taylor, V., Toth, E., Twells, L., Tytus, R., Walji, S., Walker, L., Wicklum, S., 2020. Obesity in adults: A clinical practice guideline. CMAJ 192, E875–E891. https://doi.org/10.1503/cmaj.191707.

Zeballos, E., Todd, J.E., 2020. The effects of skipping a meal on daily energy intake and diet quality. Public Health Nutr. 23, 3346–3355. https://doi.org/10.1017/S1368980020000683.