

Food Purchasing Behaviors and Sugar-Sweetened Beverage Consumption among Canadian Secondary School Students in the COMPASS Study

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ABSTRACT

Objectives: To examine whether several food purchasing behaviors (ie, sources of meals or snacks) are associated with adolescents' sugar-sweetened beverage (SSB) consumption and whether these associations vary by province.

Design: Cross-sectional observational study.

Setting: Alberta and Ontario, Canada.

Participants: Secondary school students from Alberta (n = 3,300) and Ontario (n = 37,999) participating in year 2 (2013–2014) of the Cannabis Use, Obesity, Mental Health, Physical Activity, Alcohol Use, Smoking, Sedentary Behavior (COMPASS) study.

Main Outcome Measures: Participants' self-reported frequency of consuming 3 SSB types (soft drinks, sweetened coffees/teas, and energy drinks) in a typical week.

Analysis: Hierarchical Poisson regression analyses.

Results: Participants from Alberta had a significantly ($P < .05$) higher rate of consuming SSBs and purchasing meals or snacks from school food outlets compared with their Ontario counterparts. Most of the food purchasing behaviors were significantly ($P < .05$) and positively associated with greater rates of SSB consumption. Meal or snack purchases on weekends (vs weekdays) and from food outlets off school property (vs on school property) had a greater association with SSB consumption. Eating a home-packed lunch was protective against SSB consumption across models.

Conclusions and Implications: Adolescents' food purchasing behaviors have a significant impact on their propensity for SSB consumption. These data demonstrate potentially important contexts for SSB consumption and have implications for possible settings and strategies for future interventions to reduce adolescents' SSB intake.

Key Words: adolescent, nutrition policy, secondary schools, sugar-sweetened beverages, energy drinks (*J Nutr Educ Behav.* 2018;■■:■■–■■.)

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INTRODUCTION

Adolescents are the largest consumers of sugar-sweetened beverages (SSBs) in Canada¹ and many Canadian adolescents consume SSBs daily.² Sugar-sweetened beverages are composed of

a variety of beverages containing added sugars, including regular (ie, non-diet) sodas, fruit drinks, sports drinks, energy drinks, flavored dairy drinks, and sweetened coffees and teas. Excess SSB consumption is associated with an increased risk of obesity,³⁻⁵ lower intake

of vitamins and nutrients,^{6,7} and cardiovascular disease.^{8,9} Adolescents are a priority group for interventions to decrease SSB intake, particularly because dietary habits may persist into adulthood.¹⁰

Schools represent a viable setting for population health interventions directed at youth, owing to their population coverage, the time adolescents spend in school, and the presence of policies, programs, and infrastructure that may influence students' behavior. Canadian provincial school nutrition policies consistently recommend limiting the sale of SSBs in school food outlets (eg, cafeterias and vending machines), although these policies differ in scope. For example, the *Alberta Nutrition*

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*Guidelines for Children and Youth*¹¹ offers voluntary recommendations related to the sale of beverages within several youth-oriented settings, including limiting the availability of caffeinated and/or sweetened (both sugar- and artificially sweetened) beverages while ensuring access to water, milk, fortified soy beverages, and 100% vegetable and fruit juices. In contrast to Alberta's voluntary approach to school nutrition policy, the Ontario Ministry of Education implemented Policy/Program Memorandum No. 150 (P/PM 150),¹² which became mandatory in publicly funded schools in September, 2011. The policy prohibits the sale of many SSBs in public secondary schools, including <100% juice drinks, all sports drinks, all energy drinks, and other beverages (eg, soft drinks, flavored waters, and ades) and iced teas containing >40 calories or caffeine.¹²

While each Canadian province has developed school nutrition policies to support healthy school foods, previous research demonstrates that Canadian schools do not consistently comply with these policy recommendations, given the availability of policy-noncompliant products for sale through Canadian school food outlets.¹³⁻¹⁵ Furthermore, there is evidence of a higher degree of non-compliance with school nutrition policies (and thus a greater availability of less healthful foods and beverages) among schools in provinces with voluntary school nutrition policies,¹⁴ perhaps owing to the numerous barriers to adopting guidelines voluntarily.^{13,16,17} It is unclear whether adolescents' use of school food outlets relates to SSB intake, in part because of the limited data on adolescents' food purchasing behaviors and whether these decisions relate to diet quality.^{18,19} Although earlier Canadian studies identified associations between SSB intake and weekday lunch behaviors,^{15,16} there has been limited examination of snack purchasing and weekend food purchasing behaviors and their relation to SSB consumption among adolescents.

This study examined whether various meal and snack purchasing behaviors on weekdays and weekends are associated with adolescents' weekly consumption of 3 types of SSBs (soft drinks, sweetened coffees/teas, and

energy drinks) in a sample of adolescents from Alberta and Ontario. This study also investigated whether these associations vary by province, to test the hypothesis that the magnitude of association between SSB consumption and purchases from school food outlets is greater among adolescents in Alberta compared with Ontario, as a possible reflection of voluntary vs mandatory provincial school nutrition policies.

METHODS

Design

Cannabis Use, Obesity, Mental Health, Physical Activity, Alcohol Use, Smoking, Sedentary Behavior (COMPASS) is a 9-year longitudinal prospective cohort study (from 2012–2013 to 2021–2022) designed to collect hierarchical data annually from a sample of adolescents attending secondary schools (ie, schools composed of grades 9–12) in Alberta and Ontario, Canada. This study used data from year 2 (Y₂) of COMPASS (2013–2014). The University of Waterloo Office of Research Ethics and participating school boards' internal committees reviewed and approved all aspects of the study protocol.

Sample

The COMPASS recruitment process was multistage. First, participating school boards were purposely selected based on the following criteria: (1) they spoke English; (2) they granted approval to the study protocol; and (3) they gave permission for use of active information passive consent parental permission protocols. The researchers chose a passive consent protocol because active consent procedures are associated with low student participation rates in school-based studies, falsely inflated between-school variance, misrepresentative sample demographics, and the ability to identify individual participants.²⁰ All schools within eligible school boards were approached to participate. Participating schools were required to meet the following criteria: (1) secondary school with students in grades 9–12; (2) minimum enrollment of 100 students/grade; and (3) operated in a standard school or classroom setting. The Y₂

sample was composed of 89 secondary schools from Alberta (n = 10) and Ontario (n = 79).

Parents and guardians of students attending participating schools received a study information letter. Parents and guardians who did not want their child to participate could withdraw the child from the study by contacting a COMPASS recruitment coordinator via telephone or e-mail. All students whose parents passively consented for their child to participate were eligible to participate. Students were able to withdraw from the study at any time. A total of 57,229 students were enrolled in the Y₂ schools within Alberta (n = 4,700) and Ontario (n = 52,529). Ultimately, 79.2% of students (n = 45,298) enrolled in Y₂ COMPASS schools participated in the study. Students missing data on outcome and/or control variables (ie, relating to SSB consumption and sociodemographic characteristics, described subsequently) were excluded from analyses (n = 3,999; 8.8%), with the exception of participants with missing body mass index (BMI) data. The final sample was composed of 41,299 participants, representing 70.2% (n = 3,300) and 72.3% (n = 37,999) of students enrolled at COMPASS schools in Alberta and Ontario, respectively.

Data Sources

All student-level data (ie, outcome, control, and explanatory variables) were collected through the COMPASS Student Questionnaire, a paper-based survey composed of questions on many health, social, and academic outcomes. The questionnaire previously underwent validity and reliability testing and performed well in these assessments.^{21,22}

Outcome Variables

Participants were asked to indicate the number of days during a usual school week (0–5 days) and weekend (0–2 days) on which they consume each of the following: (1) sugar-sweetened beverages (soda, Kool-Aid, Gatorade, etc), (2) high-energy drinks (Red Bull, Monster, Rockstar, etc), and (3) coffee or tea with sugar (cappuccino, Frappuccino, iced tea, iced coffees, etc). This first SSB category (ie, contain-

ing soda, fruit drinks, and sports drinks) is referred to here as soft drinks. Participants were advised not to include diet drinks when reporting their soft drink intake. Consistent with previous research,²³ participants' responses to these questions were used to generate the 4 SSB-related outcome variables of interest: weekly rate of each of soft drink, sweetened coffee/tea, and energy drink consumption, as well as a composite SSB score.

The researchers derived the weekly rate of the 3 SSB categories examined by summing the number of weekdays and weekends participants reported consuming each category of SSB. Possible values for these 3 outcomes ranged from 0 to 7 d/wk. Participants' intake of all 3 SSB categories were assessed through a composite SSB score derived by summing their weekly consumption (in days) of each category. Possible values for this score ranged from 0 (indicating no use of any beverage category on any day) to 21 (indicating use of all 3 SSB categories every day). This composite score was intended to reflect a more comprehensive measure of participants' total SSB consumption, in addition to their consumption of discrete SSB categories.

Control and Explanatory Variables

Control variables included participants' self-reported gender, grade, ethnicity, weight status (ie, BMI [kg/m^2] category based on reported height and weight, and World Health Organizations classifications, adjusted for age and sex²⁴), personal weekly spending money, truancy, and weight goal. The weight status variable was categorical and had 5 levels: underweight, healthy weight, overweight, obese, and missing (ie, for participants who were missing BMI data).

Potential explanatory variables described adolescents' food purchasing behaviors on weekdays and weekends. The 5 weekday behaviors included the number of school days (0–5) on which participants typically (1) ate a home-packed lunch at school, (2) purchased lunch in the school cafeteria, (3) purchased snacks from school vending machines, (4) purchased lunch in fast-food places/restaurants, and (5) purchased snacks

from convenience food outlets (eg, vending machines, corner stores, snack bars) off school property. The 2 weekend behaviors included the number of weekend days (0–2) on which participants typically (1) purchased food from fast-food places or restaurants, and (2) purchased snacks from convenience food outlets.

Analyses

Descriptive statistics were used to characterize the sample. Pearson's chi-square test and 2-sided Wilcoxon rank sum procedures were conducted to examine provincial differences across categorical and nonnormally distributed continuous variables, respectively.

Before developing multivariate models, the researchers performed 2 preliminary exploratory analyses. First, PROC GLIMMIX (version 9.1, SAS Institute Inc., Cary, NC, 2003) was used to generate unconditional means models with no variables and with a random intercept term (ie, null models) to examine the significance of the between-school variance for each of the 4 outcomes. For each outcome, the researchers used the school-level variance term to calculate the intraclass correlation, which represented the proportion of total variance in the SSB-related outcome caused by differences across schools. Second, variance inflation factors (VIFs) of the potential explanatory variables were examined using the VIF option in PROC REG for each outcome variable to assess risk of collinearity before modeling. Although there are no formal criteria for deciding whether a VIF is large enough to affect predicted values, it is generally accepted that VIFs exceeding 4 warrant further investigation, whereas VIFs exceeding 10 are signs of serious collinearity.

Using generalized estimating equations, the researchers developed hierarchical Poisson regression models to identify whether adolescents' food purchasing behaviors were associated with the 4 outcomes, which reflected counts. To control for the clustered nature of the study (ie, students within the same school were more likely to be similar across outcomes than were students at different schools, and therefore not independent), a repeat subject representing

school and an exchangeable (compound symmetric) covariance matrix were specified. The modeling approach taken was consistent with related research.²³ A separate model was developed for each SSB outcome using a multistep process. First, a series of univariate analyses was undertaken to identify whether each potential explanatory variable was independently associated with each outcome. To be reasonable yet not overly restrictive at this screening stage, variables that were not statistically significant ($P > .2$) in the univariate models were removed from the analysis. Second, all significant variables from this first screening stage were included in a joint multivariate model. Control variables were included in each model regardless of their statistical significance, to minimize confounding.

The researchers used 3 strategies to assess the effect of province on associations between outcome variables and food purchasing behaviors: (1) stratification by province (ie, running a separate model for each province), (2) including province as a main effect, and (3) examining interaction effects between province and food purchasing behaviors (ie, including province as a main effect). All analyses were performed using SAS software (version 9.4, SAS Institute Inc., Cary, NC, 2013).

RESULTS

Participants' Sociodemographic Characteristics

Within the total sample, there was roughly an equal representation of boys and girls across the 4 grades (Table 1). Most participants were white (75.1%) and had a healthy weight (57.6%). The predominant weight goal was to lose weight, reported by 41.2% of participants. There were significant provincial differences in participants' sociodemographic and behavioral characteristics (Tables 1 and 2).

Participants' Food Purchasing Behaviors and SSB Consumption

Table 2 demonstrates that participants reported most frequently eating a home-packed lunch at school (mean, 3.0 days in a typical school week); however, school cafeterias and

Table 1. Characteristics of Sample of Secondary School Students Participating in Year 2 of the COMPASS Study from Alberta (n = 3,300) and Ontario (n = 37,999), Canada

Characteristic	Total (n [%])	Alberta (n [%])	Ontario (n [%])	P ^a
Gender				.63
Female	20,733 (50.2)	1,670 (50.6)	19,063 (50.2)	
Male	20,566 (49.8)	1,630 (49.4)	18,936 (49.8)	
Grade				< .001
9	10,657 (25.8)	487 (14.8)	10,170 (26.8)	
10	10,876 (26.3)	1,065 (32.3)	9,811 (25.8)	
11	10,329 (25.0)	939 (28.4)	9,390 (24.7)	
12	9,437 (22.9)	809 (24.5)	8,628 (22.7)	
Ethnicity				< .001
White	31,003 (75.1)	2,440 (73.9)	28,563 (75.2)	
Aboriginal	1,432 (3.5)	354 (10.7)	1,078 (2.8)	
Asian	2,114 (5.1)	128 (3.9)	1,986 (5.2)	
Black	1,498 (3.6)	58 (1.8)	1,440 (3.8)	
Latin	765 (1.8)	12 (0.4)	753 (2.0)	
Other	4,487 (10.9)	308 (9.3)	4,179 (11.0)	
Weekly spending money (\$)				< .001
0	6,557 (15.9)	464 (14.1)	6,093 (16.0)	
1–20	11,893 (28.8)	612 (18.5)	11,281 (29.7)	
21–100	11,019 (26.7)	943 (28.6)	10,076 (26.5)	
>100	6,621 (16.0)	755 (22.9)	5,866 (15.5)	
I don't know/missing	5,209 (12.6)	526 (15.9)	4,683 (12.3)	
Weight status				< .001
Underweight	643 (1.6)	55 (1.7)	588 (1.5)	
Healthy weight	23,793 (57.6)	1,795 (54.4)	21,998 (57.9)	
Overweight	5,883 (14.3)	479 (14.5)	5,404 (14.2)	
Obese	2,647 (6.5)	270 (8.2)	2,377 (6.3)	
Missing	8,333 (20.2)	701 (21.2)	7,632 (20.1)	
Truancy				< .001
Skipped 0 classes in past 4 wk	29,406 (71.2)	2,091 (63.4)	27,315 (71.9)	
Skipped ≥1 classes in past 4 wk	11,893 (28.8)	1,209 (36.6)	10,684 (28.1)	
Weight goal				< .001
Not trying to do anything about weight	9,406 (22.8)	891 (27.0)	8,515 (22.4)	
Gain weight	7,444 (18.0)	478 (14.5)	6,966 (18.3)	
Lose weight	17,015 (41.2)	1,365 (41.4)	15,650 (41.2)	
Stay same weight	7,434 (18.0)	566 (17.1)	6868 (18.1)	

COMPASS indicates Cannabis Use, Obesity, Mental Health, Physical Activity, Alcohol Use, Smoking, Sedentary Behavior.

^aPearson's chi-square test was used to examine differences by province.

fast-food places or restaurants were also common lunch sources. Participants from Alberta were more likely to make purchases from food outlets on and off

school property on weekdays, compared with their Ontario counterparts. Participants reported consuming soft drinks most frequently (mean, 2.7 days

in a typical week) and energy drinks least frequently (mean, 0.5 days in a typical week). The rate of SSB intake was significantly greater across all cat-

Table 2. Self-reported Food Purchasing Behaviors and SSB Consumption of a Sample of Secondary School Students Participating in Year 2 of the COMPASS Study from Alberta (n = 3,300) and Ontario (n = 37,999), Canada

Characteristic	Total (Mean ± SD)	Alberta (Mean ± SD)	Ontario (Mean ± SD)	P ^a
Weekday food purchasing behaviors ^b				
Frequency of eating home-packed lunch at school	3.0 ± 2.0	2.6 ± 2.0	3.1 ± 1.97	< .001
Frequency of purchasing lunch from school cafeteria	1.0 ± 1.4	1.1 ± 1.4	1.0 ± 1.41	< .001
Frequency of purchasing snacks from school vending machines	0.3 ± 0.8	0.8 ± 1.2	0.3 ± 0.76	< .001
Frequency of purchasing lunch in fast-food places/restaurants	0.8 ± 1.3	1.1 ± 1.4	0.8 ± 1.27	< .001
Frequency of purchasing snacks from convenience food outlet off school property	0.5 ± 1.0	0.7 ± 1.2	0.4 ± 0.96	< .001
Weekend food purchasing behavior ^c				
Frequency of purchasing food from fast-food places or restaurants	0.5 ± 0.6	0.5 ± 0.6	0.6 ± 0.60	< .001
Frequency of purchasing snacks from convenience food outlets	0.2 ± 0.5	0.2 ± 0.5	0.2 ± 0.49	.17
Weekly SSB consumption				
Soft drinks ^d	2.7 ± 2.3	2.9 ± 2.3	2.7 ± 2.27	< .001
Sweetened coffees/teas ^d	2.1 ± 2.4	2.2 ± 2.4	2.0 ± 2.37	< .001
Energy drinks ^d	0.5 ± 1.3	0.8 ± 1.7	0.4 ± 1.22	< .001
Composite SSB score ^e	5.2 ± 4.1	5.9 ± 4.5	5.1 ± 4.03	< .001

COMPASS indicates Cannabis Use, Obesity Mental Health Physical Activity Alcohol Use Smoking Sedentary Behavior; SSB, sugar-sweetened beverage.

^aTwo-sided Wilcoxon rank sum procedure was used to examine differences by province. ^bNumber of days in a typical school week (Monday through Friday, 0–5 days). ^cNumber of days in a typical weekend (Saturday and Sunday, 0–2 days). ^dNumber of days participants reported consuming SSBs in a typical week (Monday through Sunday, 0–7 days). ^eComposite score ranging from 0 to 21, representing the sum of participants' weekly rates of consuming the 3 distinct SSB categories.

egories among participants from Alberta. Descriptive analyses demonstrated varying patterns of SSB intake; both no use and daily use of SSBs were common, particularly with respect to soft drink consumption. For example, 22.8% of participants indicated no use of soft drinks within a typical week, whereas 9.9% reported intake of soft drinks daily.

Preliminary Analyses

The unconditional means (ie, random intercepts) models demonstrated significant between-school variation across all outcome variables ($P < .05$). School-level differences accounted for 1.9%, 0.8%, 1.9%, and 1.6% of variability in students' weekly rate of consuming soft drinks, sweetened coffees/teas, and energy drinks, as well as their composite SSB score, respectively, when controlling for individual-level variance. Pre-modeling collinearity diagnostics revealed

minimal risk of collinearity, because none of the VIFs exceeded 2.

Multivariate Models

All 7 explanatory variables were significantly ($P < .001$) independently associated with each of the 4 outcome variables within the univariate analyses screening stage, thus within the $P < .2$ threshold. As such, all 7 variables were jointly included in a multivariate model for each outcome. Within this joint model stage, parameter estimates corresponding to the food purchasing behaviors were similar across models that were stratified by province. For most explanatory variables, 95% confidence intervals across the province-stratified models overlapped. However, within the models for weekly soft drink consumption, the 95% confidence intervals corresponding to the frequency of purchasing lunch in the school cafeteria variable did not overlap between the province-

stratified models, but were close. The analysis proceeded to the strategy of including province as a main effect in each model.

Province was significantly associated ($P < .05$) with all but 1 of the SSB outcomes (weekly rate of sweetened coffee/tea consumption) in multivariate models containing only control variables. Specifically, being from Alberta was associated with a greater number of days of SSB consumption among participants, after adjusting for control variables. However, the effect of province lost its statistical significance after adding the food purchasing behavior variables. After adjusting for the control variables and province, most food purchasing behaviors examined were significantly associated with increases in participants' days of SSB consumption (Table 3). Conversely, eating a home-packed lunch was protective against days of SSB consumption across all models. Generally, the effects sizes associated with

Table 3. Food Purchasing Behavior-Related Correlates of Weekly SSB Consumption Among Secondary School Students (n = 41,299) From Alberta and Ontario, Canada, Participating in Year 2 of the COMPASS Study

Variable	Weekly SSB Consumption ^a			
	Composite SSB Score ^c	Soft Drinks	Sweetened Coffees/Teas	Energy Drinks
Province				
Ontario	1.00	1.00	1.00	1.00
Alberta	1.03 (0.97–1.10)	1.02 (0.98–1.07)	0.95 (0.87–1.05)	1.13 (1.00–1.29)
Weekday food purchasing behaviors ^d				
Frequency of eating home-packed lunch at school	0.98 (0.97–0.98) ^{***}	0.99 (0.99–1.00) [*]	0.98 (0.97–0.99) ^{***}	0.92 (0.91–0.93) ^{***}
Frequency of purchasing lunch in school cafeteria	1.03 (1.02–1.03) ^{***}	1.03 (1.02–1.04) ^{***}	1.03 (1.02–1.03) ^{***}	1.02 (1.01–1.03) ^{**}
Frequency of purchasing snacks from school vending machine	1.05 (1.04–1.06) ^{***}	1.01 (0.99–1.02)	1.05 (1.03–1.06) ^{***}	1.13 (1.11–1.15) ^{***}
Frequency of purchasing lunch in fast-food places or restaurants	1.07 (1.07–1.08) ^{***}	1.07 (1.07–1.08) ^{***}	1.06 (1.05–1.08) ^{***}	1.07 (1.06–1.09) ^{***}
Frequency of purchasing snacks from convenience food outlets off school property	1.08 (1.07–1.09) ^{***}	1.07 (1.06–1.08) ^{***}	1.06 (1.05–1.07) ^{***}	1.14 (1.12–1.15) ^{***}
Weekend food purchasing behaviors ^e				
Frequency of purchasing food from fast-food places or restaurants	1.17 (1.15–1.18) ^{***}	1.19 (1.18–1.21) ^{***}	1.11 (1.09–1.13) ^{***}	1.20 (1.17–1.23) ^{***}
Frequency of purchasing snacks from convenience food outlets	1.13 (1.12–1.15) ^{***}	1.11 (1.10–1.13) ^{***}	1.08 (1.06–1.10) ^{***}	1.32 (1.28–1.36) ^{***}

COMPASS indicates Cannabis Use, Obesity, Mental Health, Physical Activity, Alcohol Use, Smoking, Sedentary Behavior; SSB, sugar-sweetened beverage.

^aNumber of days participants reported consuming SSBs in a typical week (Monday through Sunday, 0–7 days). ^bRates were adjusted for all other variables in the column in addition to gender, grade, province, ethnicity, weekly spending money, body mass index category, truancy, and weight goal. ^cComposite score ranging from 0 to 21, representing the sum of participants' weekly rates of consuming the 3 distinct SSB categories. ^dNumber of days in a typical school week (Monday through Friday, 0–5 days). ^eNumber of days in a typical weekend (Saturday and Sunday, 0–2 days); * $P < .05$, ** $P < .01$, *** $P < .001$.

weekend food purchasing behaviors were greater than those of weekday behaviors. Likewise, use of off school property food outlets was associated with greater increases in participants' days of SSB consumption than was use of school food outlets. However, the magnitude of the difference in effects sizes between food outlets on school property vs off school property was less than that of weekend vs weekday food purchasing behaviors. Furthermore, there was an overlap in the confidence intervals of purchasing from school vending machine variables and from off-school property weekday food purchasing variables in the models for weekly sweetened coffee/tea consump-

tion and weekly energy drink consumption. Figure 1 shows the adjusted rates from the final composite SSB score model.

The researchers also tested interaction effects between province and all food purchasing behaviors. Of the 28 interaction effects tested (ie, 7 interaction effects \times 4 outcomes), only 1 was significant at $P < .05$ (Figure 2). This effect suggested that the more frequently a student purchased lunch from the school cafeteria, the greater their rate of weekly soft drink consumption, especially among students in Alberta. A number of interaction effects were significant at $P < .10$ in the weekly soft drinks model as well, in-

cluding the interaction between province and weekday frequency of bringing a home-packed lunch, weekday frequency of purchasing snacks from a school vending machine, and weekday/weekend frequency of purchasing snacks from convenience food outlets off school property. For all of these effects, the association between the food purchasing behavior and frequency of soft drinks consumption was more pronounced among students from Alberta.

DISCUSSION

This study identified associations between adolescents' weekday and

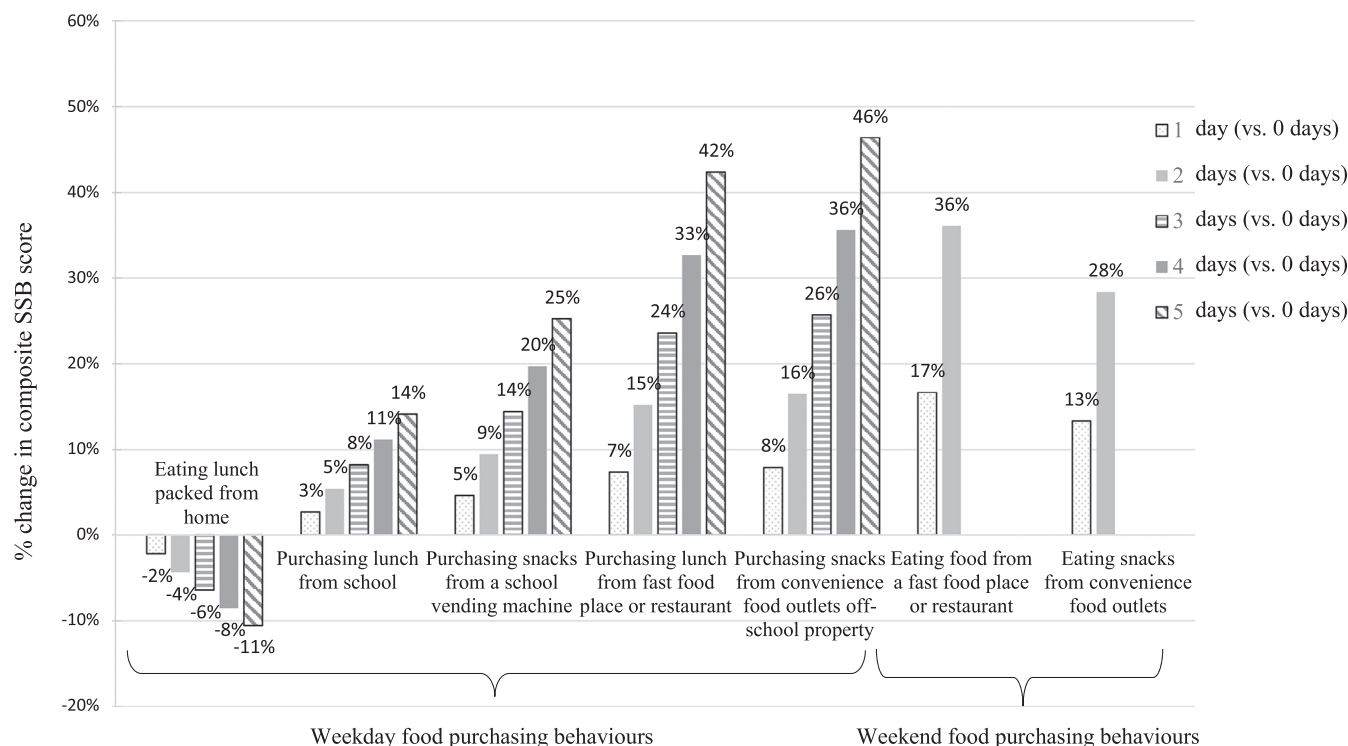


Figure 1. Percent change in composite sugar-sweetened beverage (SSB) score associated with different frequencies of food purchasing behaviors, controlling for all control and explanatory variables.

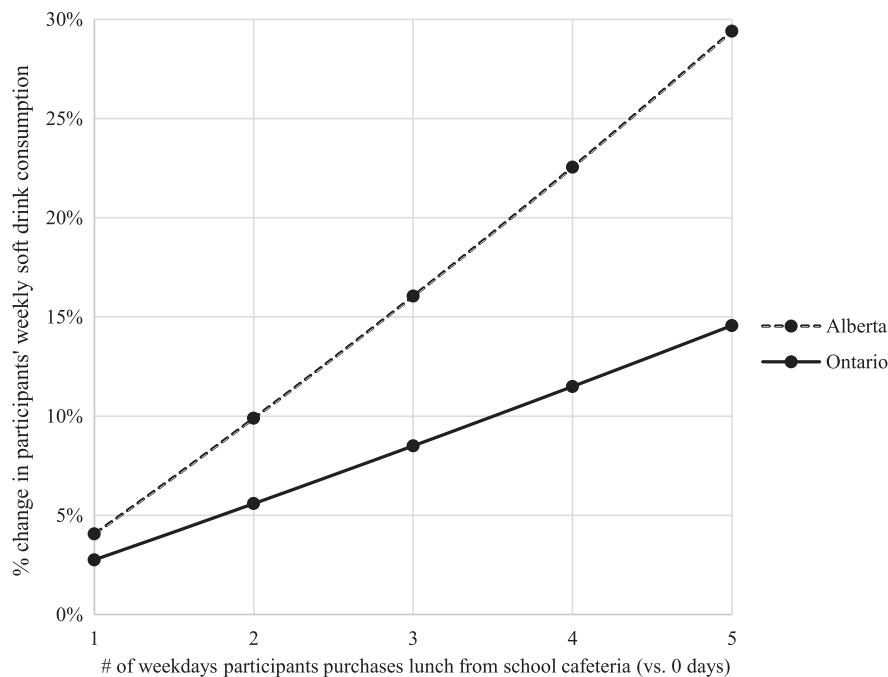


Figure 2. Percent change in rate of weekly soft drink consumption as a function of province and the number of weekdays on which participants purchased lunch from their school cafeteria, controlling for all control and explanatory variables.

weekend food purchasing behaviors and their SSB intake. The data demonstrate potentially important contexts for adolescents' SSB consumption and possible settings and strategies for future interventions to reduce youths' SSB consumption. This study identified that weekend food purchasing behaviors have a greater association with adolescents' days of SSB consumption compared to their weekday food choices. There has been a limited investigation of differences in adolescents' dietary behaviors on weekends vs weekdays (eg, due to the popularity of 24-hour dietary recall in many nutrition surveys, which are often administered in schools and, thus, on weekdays), precluding the ability to compare this result with previous Canadian literature. An Australian study identified that female adolescents demonstrated comparable SSB consumption on weekdays and weekend days, while males showed a more than three-fold increase in their SSB intake on weekends relative to weekdays.²⁵ However, to our knowledge, these

findings have not been replicated in other contexts. Differences in dietary intake and behaviours on weekdays versus weekends likely reflect variation in the physical and social contexts in which adolescents spend their time in these 2 periods. For example, since Canadian youth do not go to school on weekends, they have more time for leisure activities (eg, eating out for meals, shopping, etc.) on weekends. The difference in the magnitude of the association between frequency of SSB intake and weekday vs weekend dietary behaviors may be useful in informing decisions on prioritizing settings and strategies for reducing adolescents' SSB intake. Previous research demonstrates that school-based initiatives have limited influence on students' SSB intake during their leisure time,²⁶ implying that there are minimal "carry-over" intervention effects. This finding, coupled with this current study's results, suggest that broader population-level strategies (ie, those centered on the larger food, home, and media environments that surround youth throughout the week) to reduce access to and attractiveness of SSBs are likely better poised to address adolescents' consumption of these products.

This study's findings demonstrate that adolescents regularly use school food outlets for food purchases and that these purchases represent an important predictor of SSB consumption. Previous Canadian studies reported similar associations,^{18,19} although neither examined snack or weekend purchasing behaviors. It is plausible that these associations reflect the presence of SSBs in schools, given evidence that many Canadian secondary schools have less healthful beverages available for sale.^{14,15} However, this cannot be inferred, because the availability of SSBs in school food outlets was not examined within this study. Purchasing meals and snacks from food outlets off school property appeared to be a greater correlate of SSB consumption among adolescents than did purchasing from school food outlets. Canadian adolescents tend to have at least 1, if not many more, food outlets within close proximity of their schools.²⁷⁻²⁹ Because these outlets are off school property, they are exempt from school nutrition policies and not

restricted in their availability of SSBs and other policy-noncompliant products. Given the popularity of food outlets within schools and the school neighborhood for lunch and snack purchases, an opportunity exists to modify the school food environment to improve youths' dietary outcomes (eg, through efforts to limit students' access to off-school property food outlets and increase the availability and appeal of healthier choices in school food outlets).

This study's results demonstrated that eating a packed lunch from home was not associated with increased rate of SSB consumption, although the effect sizes were modest. Encouragingly, this was the predominant lunch choice among participants, consistent with previous Canadian research.^{18,19} Because home-packed lunches are exempt from school nutrition policies, they may include SSBs and other unhealthy products. However, because home-prepared meals are often more nutritious than purchased meals,¹⁹ school stakeholders should encourage adolescents to eat a healthy home-packed lunch (eg, through in-school cooking classes focused on nutritious lunch preparation and by developing students' food skills). Furthermore, this finding underscores the importance of parents and guardians having the necessary resources (eg, food skills and knowledge, time, access to affordable and healthy food) to ensure their children have a nutritious home-packed school lunch.

This study found that compared with participants in Ontario, those from Alberta had a higher rate of both consuming SSBs (across all beverage categories) and purchasing meals and snacks from food outlets in their school. These descriptive findings support the study hypothesis that the magnitude of relationships between SSB consumption and food purchasing behaviors was greater among Albertan participants, reflecting Alberta's voluntary provincial school nutrition policies and the resulting greater availability of noncompliant beverages in schools. The interaction effects identified further support for the study hypothesis, although only 1 of these effects was statistically significant. The remaining effects, although interesting, were not signif-

icant, but warrant further exploration in future research on the impact of school nutrition policies on students' food purchasing behaviors and/or SSB consumption. Canadian studies demonstrated that these policies can have a favorable impact on youths' dietary behaviors and the quality the school food environment.^{30,31} However, several limitations prevent current school nutrition policies from achieving this potential, including a lack of consistency, clarity, enforcement, and government resources to support policy implementation and adherence^{14,27}; these limitations suggest that these policies can be strengthened to better support a healthier school food environment.

This research had many strengths. The study had a large sample size drawn from 2 provinces and 89 schools, representing a variety of socioeconomic and geographic contexts. The questionnaire captured multiple days of dietary behaviors, which better represented participants' typical diets compared with methods that inquire about consumption within shorter time frames (eg, 24-hour recall).² This study also extended previous COMPASS analyses that focused exclusively on soft drinks¹⁸ by examining participants' consumption of several varieties of SSB, reflecting the diversity of products available on the market.

There were limitations to this study, many of which reflect the challenges inherent in secondary data analysis. This study was cross-sectional; therefore, the authors are unable to report that the associations noted were causal. Measures of participants' SSB consumption likely underestimate adolescents' true SSB intake owing to the unit of measure used (ie, compared with volume or number of servings of SSBs consumed) and because certain SSBs (eg, sweetened dairy-based beverages) were not captured on the questionnaire. Although the questionnaire collected data on many food purchasing behaviors, it was impossible to distinguish among the contributions of different environments (eg, school food outlets, food outlets surrounding schools, home) to participants' reported SSB intake. As such, interpretations of findings reflect the assumption that adolescents'

purchases of meals and snacks represent possible sources of the SSBs they consume. The observed associations may result from other individual-level factors not examined in the current analyses. This study used self-reported data, which may have introduced social desirability and recall bias, resulting in participants underreporting SSB consumption and/or misrepresenting their height or weight.³² Furthermore, the research design used in the study could not adequately account for all potentially relevant provincial differences that may have affected SSB consumption in a cross-sectional study, which impeded the ability to test the study hypothesis robustly relating to differing provincial school nutrition policies. By the same token, the significant effects described (eg, between province and discrete food purchasing behaviors) may have resulted from noise in the data, given that the variables represent approximations of adolescents' actual dietary behaviors. These effects should be interpreted with caution. Finally, COMPASS uses a convenience sample of schools and therefore is not provincially or nationally representative. Nevertheless, these findings may be relevant in similar contexts.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Many adolescents purchase lunch and snacks from food outlets on and near school property, and these behaviors are important predictors of SSB consumption. Strategies to improve the school food environment to promote healthier dietary choices include increasing accessibility and use of water fountains, stocking healthy choices in prominent places, offering these choices at an attractive cost, and eliciting student feedback on menus.¹⁷ Interventions to discourage students from visiting off-school property food outlets include policies to limit the development of new fast-food restaurants in school neighborhoods,³³ extending the scope of provincial school nutrition policies to other venues (eg, community centers),²⁷ and enforcing closed campus policies.¹⁶ There has

been limited evaluation of these interventions in Canada, which reflects a priority area for future research.

The study findings suggest that schools should provide a supportive context to encourage eating home-packed lunches, which may include an attractive designated eating space, allowing sufficient time for eating, and providing access to microwaves and refrigerators. Nutrition education and programs to develop students' food skills may also be helpful in increasing students' interest and ability to prepare healthy meals.³⁴ These strategies may counteract some existing social barriers to eating a home-prepared lunch cited by adolescents, including a desire for autonomy over food choice and perceptions that purchasing lunch is a marker of social status.¹⁶

Although this study identified some evidence suggesting that school characteristics are important determinants of students' rate of SSB intake, the findings demonstrate that other contexts (eg, the larger food, home, and media environments) may be more appropriate settings for population-health interventions to reduce adolescents' SSB consumption. Examples of these broader initiatives include implementing a new tax on SSBs and artificially sweetened beverages and banning advertising of foods and beverages to children. In addition, the recent Canadian Senate report recommended that the federal government implement these interventions among several other policies to improve Canadians' diets.³⁵ Future evaluation studies will be instrumental in identifying the effectiveness of these broader population health interventions.

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CONFLICT OF INTEREST

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