Do School Junk Food Bans Improve Student Health? Evidence from Canada

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Six provinces canadiennes ont interdit la vente de malbouffe dans les écoles afin d'améliorer la santé des enfants en s'attaquant entre autres à l'obésité. Cette mesure a été appliquée à différents moments et de façons différentes selon les provinces, et l'on observe également des différences à l'intérieur des provinces selon le nombre d'années pendant lesquelles des jeunes ont fréquenté l'école après la mise en place de la mesure. L'auteur de cet article montre, à l'aide d'une analyse de données de l'Enquête sur la santé dans les collectivités canadiennes, que chaque année pendant laquelle la malbouffe a été interdite est associée à une diminution de l'indice de masse corporelle d'environ 0,05. L'auteur montre également que, chez les élèves qui avaient fréquenté pendant cinq ans ou plus une école où la malbouffe était interdite, l'indice de masse corporelle diminuait de l'équivalent d'environ deux livres pour un individu mesurant six pieds et cinq pouces.

Mots clés : obésité, malbouffe, santé des écoliers, nutrition scolaire

Six Canadian provinces have banned the sale of junk food on school property to address child health issues such as obesity. Differences in the timing of the introduction of provincial policies provide variation in treatment across provinces, and variation within provinces comes from differences across students in the number of years of schooling during which junk food was banned. Using data from cycles of the Canadian Community Health Survey, I find that each year of a junk food ban is associated with a decline of about 0.05 body mass index. Students exposed to five or more years of a junk food ban had lower body mass index equivalent to a decrease of about two pounds for an individual who is five feet, six inches tall.

Keywords: obesity, junk food, student health, school nutrition

Introduction

The rising number of overweight and obese youth in Canada and other developed countries over the past 30 years is an important public health issue (Ogden et al. 2002, 2012; Roberts et al. 2012; Shields 2006). Obesity is associated with several negative health (and economic) outcomes later in life and, therefore, future health care expenditures, making curtailing rising obesity rates among youth an important policy goal. Although the reasons for the rise in obesity are complex,[1] public health policy has focused on improving the quantity of exercise[2] and nutrition[3] for children, particularly in the school setting.

Starting in 2005, six Canadian provinces implemented bans on the sale of junk food: foods considered to be low in nutritional quality because of high fat content, calories, sugar, or salt. The expectation for the bans is that limiting the ease of access to such food on elementary and high school property will result in students having lower consumption of low-nutrition foods and encourage an increase in their consumption of healthier foods such as fruit and vegetables, thereby decreasing the prevalence of overweight and obesity and, ultimately, other related negative outcomes such as diabetes. However, the extent to which these policies have made a difference to student weight and health outcomes is an open research question. Taber et al. (2011) estimate the association between state policies requiring or recommending that schools prohibit the sale of junk food and adolescent soda consumption and body mass index (BMI). They find that the junk food policies were associated with declines in soda consumption but not in BMI. Datar and Nicosia (2012) examine the impact of junk food availability in schools on fifth-grade US students, and they find no significant impact on obesity or BMI. Anderson and Butcher (2006) find that access to junk food due to school fundraisers is associated with an increase in students' BMI.

In this article, I attempt to measure the causal impact of school junk food bans implemented in Canadian

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provinces on the BMI of Canadians exposed to the bans while in school using a difference-in-differences methodology. At this time, six Canadian provinces have school junk food bans, and four provinces and the three territories do not. The first provincial ban occurred in New Brunswick in 2005, thus as of 2013—which is the latest year for which I have data—I observe students who have been in a school under a junk food ban for as many as eight school years. I use the number of school years an individual was exposed to the school-based junk food ban as my policy exposure variable, which therefore varies from zero to eight. Unlike a binary policy exposure variable often used in difference-in-differences estimations, my policy exposure measure allows for the dose of the intervention to vary. Student exposure to school junk food bans began at different ages and in different years, providing variation in treatment exposure within and across provinces and years.[4] Data for my study come from all available cycles of the Canadian Community Health Survey (CCHS), a nationally representative survey conducted biannually from 2000 to 2007 and annually since 2007.

I find that exposure to provincewide junk food bans while in school has the expected negative effect on BMI. Point estimates of the policy effect are larger and significant at the 5 percent level for Canadians who were in school for five years or more in which the junk food ban was in place. The effect of the junk food ban is additive with respect to the number of years someone is exposed to it in school. For individuals who were in school for five years in which the junk food ban was in place, BMI is 0.3 lower, which is equivalent to about two pounds for an individual who is five feet, six inches tall. The measurable impact of the junk food ban is strongest for younger individuals in the sample who (a) have not yet graduated from high school and (b) may be less likely to be able to leave school grounds over class breaks.

The article proceeds as follows. The next section first describes the school junk food policies and then the data and identification strategy. The results are then presented, and the Discussion and Conclusion section concludes the article.

Methods and Data

Provincial Junk Food Policies

Beginning with New Brunswick and Prince Edward Island at the beginning of school year 2005/06, Canadian provinces began implementing polices to restrict the sale of junk food on elementary and high school property. Since that time, British Columbia (January 2008 for elementary, September 2008 for high school), Quebec (January 2008), Nova Scotia (January 2007), and Ontario (September 2011) have followed suit. Basic information on the provincial policies is contained in Appendix 1.[5]

In most provinces with a ban, the nutrition of a given food is graded on a three-point scale: minimum, moderate, and maximum nutritional value. A typical school policy entirely bans the sale of food of minimum nutritional value and may place restrictions on food from the moderate category. Because these bans apply to foods purchased on school property, students can therefore walk off school grounds and purchase junk food at the local convenience store or fast food restaurant. Nevertheless, these policies at least cause students wanting to purchase junk food to be inconvenienced, particularly younger students who may be less able to leave school property. As shown by Wisdom, Downs, and Loewenstein (2010), even relatively small inconveniences can influence food choices.

Data: Canadian Community Health Survey

The CCHS is a nationally representative cross-sectional survey that collects health-related information, including self-reported weight and height, for approximately 65,000 Canadians aged 12 years and older. Before 2007, the CCHS was conducted roughly every two years, with approximately double the sample size (roughly 130,000). Since 2007, it has been conducted annually. For the CCHS cycles conducted before 2007, it is possible to assign respondents to a calendar year on the basis of the data reported in the CCHS interview.

I combine data for all available cycles of the CCHS (2000,[6] 2003, 2005, and 2007–2013). Restricting the sample to respondents aged 12–26 years who have a valid BMI (measured as kg/m^2)[7] gives a sample size of just more than 153,000 observations. Of those, just more than 22,000 persons have been "treated" in the sense of having attended an elementary or high school for at least some period during which a school junk food ban was in place in a given province. To each individual, I assign a variable for the number of school years he or she was potentially affected by a school junk food ban, based on the child's age and home province as described later in this article.

The CCHS sample is stratified by province, health region, and age. In descriptive analysis, I therefore use the CCHS sampling weights provided by Statistics Canada. However, I do not use the sampling weights in the regression analysis on the grounds that the sampling probability is a function of the explanatory variables (Solon, Haider, and Wooldridge 2015) and thus using sampling weights decreases efficiency (see, e.g., Dickens 1990).

Methodological Approach

The objective of this article is to measure the causal effect of banning the sale of junk food in schools on student

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BMI. I use a difference-in-differences strategy to exploit the variation in timing across the provinces in the introduction of junk food bans, as well as differences within provinces in the timing and duration of treatment. Because my sample is cross-sectional for individuals, no individual is observed more than once, and the difference-in-differences estimator applies to groups of individuals compared before and after one (or more) of the groups is treated (see, e.g., Imbens and Wooldridge 2009, section 6.5).

As with any difference-in-differences approach, the validity of the causal interpretation of policy effects estimated by this methodology requires that several assumptions hold. The non-treated cases provide the counterfactual case to compare with the policy-treated cases: What would the outcome have been in the absence of the policy? For the non-treated cases to be a valid control sample, the common support assumption posits that the treated and non-treated cases are drawn from the same population. Second, a common trend is required in the average BMI across provinces that implement and do not implement junk food bans.[8] Finally, it must be the case that there are no pre-treatment or policy effects. I discuss the validity of these assumptions in the Results section and provide a falsification test of the latter.

Because students vary substantially in the duration for which they receive the treatment, I use the number of school years of junk food ban[9] to which the student has been subjected as the policy variable of interest. Because students of different ages begin and end treatment at different times, I observe variation within province-years as well as across years and provinces. For example, in New Brunswick in 2013 (i.e., within a province-year), the policy variable ranges from 0 years (26-year-olds, who are too old to have ever faced a ban) to 8 (youths aged 13–18 y, who were in elementary or secondary school for every year of the ban).[10] Likewise, for a child of a given age in New Brunswick, I observe variation in treatment across the CCHS survey years. For example, for 16-year-olds in New Brunswick, the treatment variable is 0 in CCHS years before the policy (2005 and earlier), 2 in CCHS 2007, and as much as 8 in CCHS 2013. I also observe variation in the policy variable resulting from different timing of policy introduction across provinces, causing changes in both the first observed year of treatment and the maximum duration of treatment. This allows me to identify the effect of the policy distinct from a year or period effect, which would not be the case if all provinces introduced the policy in the same year.

Two main drawbacks of the data set are likely attenuated by the difference-in-differences methodology and positive attributes of the data set. The first drawback, the self-reported nature of the height and weight measurements, is unlikely to cause problems in a difference-in-differences context as long as the average extent of misreporting does not change differently over time in provinces with junk food bans than in those without. The second drawback of the data is that the survey uses repeated cross-sections rather than a panel structure, so individual students are observed only once. A difference-in-differences methodology, however, is a standard approach with repeated cross-sectional data (see, e.g., Imbens and Wooldridge 2009, section 6.5), allowing for comparisons of differences in group means over time. The large sample size across all provinces and long time-series spanning the introduction of the junk food bans makes the CCHS data well suited to such comparisons of grouped means in the context of difference-in-differences across Canadian provinces.

My difference-in-differences specification is as follows:

$$\begin{aligned}\mathrm{BMI}_{ipy} &= \beta_1 + \beta_2 \mathrm{Ban\_Years}_i \\ &\quad + \sum_{a=1}^{4} \beta_{2+a} Age^a + \beta_7 \mathrm{Female}_i \\ &\quad + \beta_{8-19} \mathrm{Prov/Terr}_i + \beta_{20-28} \mathrm{Year} + \varepsilon_i,\end{aligned}$$

where BMI is the body mass index of individual i in province p in year y; Ban_Years are the school years the individual has been affected by a ban; and Female, Prov/Terr, and Year are dummy variables for gender, province, and years. I allow a very flexible functional form in age, because average BMI changes steadily over the ages of interest (see Appendix 3 for a figure showing BMI by age).[11]

To this basic specification, I also make the following additions or changes:

1. Run separate regressions for males and females (and drop the female dummy);
2. Add controls for ethnicity and race (groups are Black, South Asian, Chinese, other Asian, Aboriginal, and other, with the excluded group White) and fixed effects for the 105 health regions of Canada; and
3. Replace the continuous Ban_Years variable with three dummy variables for students affected by a junk food ban for (a) one year or less, (b) 1.5–4.5 years, and (c) five or more years.

As discussed by Bertrand, Duflo, and Mullainathan (2004), serial correlation within groups in the model's error term can lead to a downward bias in the standard errors for the difference-in-differences estimator, leading to overrejection of the null hypothesis that the policy variable coefficient is zero. This problem is partially overcome by allowing for clustering of the standard errors at the level at which the serial correlation occurs.

In all tables of regression results, I therefore present p values for standard errors clustered at two levels of aggregation. In the first case, I present results of clustering at the province–age level, on the basis that this is the level at which students are actually affected by the junk food ban policies; that is, at any given time, students are affected by junk food policies on the basis of their province and age. This results in 195 clusters (13 provinces or territories × 15 ages, ranging from age 12 y to age 26 y).

As a second level of aggregation for the clusters, I cluster the standard errors at the level of the province or territory only. This is comparable to a traditional difference-in-differences estimation clustering at the level of the state and estimating the impact of state-level policy variation. In this case, however, I have only 13 clusters—10 provinces and 3 territories—whereas cluster-robust estimation assumes a large number of clusters. For this reason, in all regressions, I first present the cluster-robust standard error; associated *p* values are then adjusted using the wild cluster bootstrap described and recommended by Cameron, Gelbach, and Miller (2008). The bootstrap procedure is a cluster generalization of the wild bootstrap for heteroskedastic regression models. I use the same variation as Cameron et al. (2008), which resamples residuals from ordinary least squares estimation that imposes the null hypothesis and uses equal Rademacher weights and probabilities with 1,000 repetitions.

Results

Summary Statistics

Figure 1 presents descriptive statistics for average BMI by gender and age group for each of the survey years. The missing years on the left-hand side of the figure reflect that the CCHS was initially conducted approximately every other year and became an annual survey in 2007. In Figure 1A, an overall upward trend is observed for the full sample, with the increase appearing to be sharper for females, albeit declining slightly in the most recent two years. To the extent that the overall trend is increasing, however, it is due to the older groups (those aged 16–20 y and 21–26 y in Figures 1C and 1D). By contrast, females have a distinct downward trend for the 12–15-year-old age group, whereas males initially decline and then increase in the most recent years.

Table 1 provides the descriptive statistics for the policy variable. Across the 13 provinces and territories, I have a

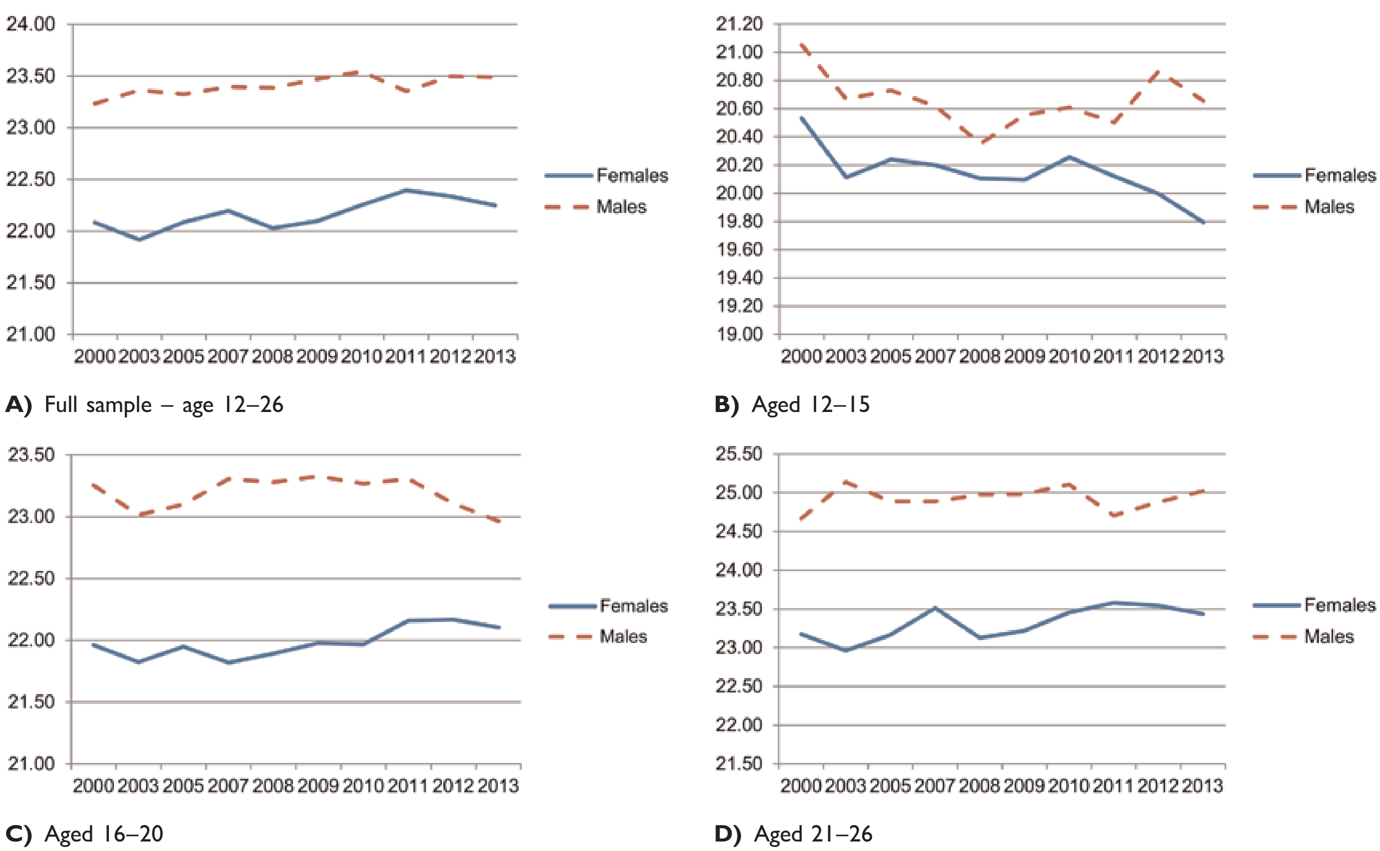

Figure 1: Mean Body Mass Index by CCHS Year: Full Sample, Aged 12–26 Years (A), Aged 12–15 Years (B), Aged 16–20 Years (C), and Aged 21–25 Years (D)
Note: Note: Uses the CCHS sampling weights provided by Statistics Canada. CCHS = Canada Community Health Survey.
Source: Author's tabulations based on pooled CCHS cross-sections.

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Table 1: Descriptive Statistics for Policy Variable, Years of Junk Food Ban

	Full Sample		Treated		
Province/Territory	*N*	Ban Years, Mean (SD)	*N*	Ban Years, Mean (SD)	Max. No. Ban Years
NF	4,880	0 (0.00)	0	—	0
PE	2,700	2.21 (2.61)	980	4.29 (2.08)	8
NS	5,730	1.37 (2.00)	1,960	3.11 (1.91)	6.5
NB	5,820	2.04 (2.56)	2,150	4.19 (2.11)	8
QC	31,090	0.98 (1.62)	8,440	2.60 (1.66)	5.5
ON	52,870	0.13 (0.44)	4,120	1.45 (0.50)	2
MB	9,680	0 (0.00)	0	—	0
SK	9,920	0 (0.00)	0	—	0
AL	18,100	0 (0.00)	0	—	0
BC	18,940	0.86 (1.58)	4,420	2.89 (1.60)	5.5
YT	1,360	0 (0.00)	0	—	0
NL	1,950	0 (0.00)	0	—	0
NU	1,660	0 (0.00)	0	—	0

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Means and standard deviations for all descriptive statistics are weighted using the CCHS sampling weights. Dashes indicate there are no mean or standard deviation since there are no treated observations in these provinces. CCHS = Canada Community Health Survey.
Source: Author's tabulations based on pooled CCHS cross-sections and Appendix 1.

total of just over 153,000 observations, of which more than 22,000 have been treated with at least a partial year of a junk food ban. Naturally, in the seven provinces and territories with no ban, the ban-years variable is zero for all observations. In the six provinces with junk food bans, the ban-years variable ranges from zero (for unaffected students) to eight for those students in New Brunswick and Prince Edward Island who experienced the full eight years of the ban.[12] The mean number of years of ban for students who have experienced at least some ban (i.e., the treated) ranges from 1.45 years in Ontario to 4.29 years in Prince Edward Island.

Difference-in-Differences Results

Table 2 presents the results of difference-in-differences estimations when the dependent variable is BMI and the policy variable is a continuous count of school years banned from junk food. For the full sample, the ban-years coefficient implies that each additional school year of exposure to a junk food ban is associated with a decrease in BMI of about 0.04 to 0.05. These coefficients are significant at the 1 percent level using the province–age clustered standard error and remain significant at the 10 percent level once using the bootstrapping procedure for the 13 province–territory clusters. Separating the sample by sex reveals that the point estimate for the ban-years coefficient is nearly twice as large for females (about 0.065) as for males (about 0.035). The coefficient remains statistically significant at the 10 percent level for females but misses significance at conventional levels for males once the bootstrapping procedure is used. In

Table 2: Estimated Effect of Junk Food Ban School Years on Youth BMI

	Full Sample		Males		Females	
Ban-years coefficient	−0.0462	−0.0525	−0.0332	−0.0380	−0.0597	−0.0648
(cluster-robust SE [prov])	(0.0183)	(0.0186)	(0.0208)	(0.0184)	(0.0263)	(0.0299)
Clustered *p* value (prov)	0.027	0.015	0.136	0.060	0.042	0.051
Clustered *p* value (prov–age)	0.001	0.001	0.043	0.036	0.005	0.006
Bootstrapped *p* value (prov)	0.078	0.060	0.208	0.114	0.088	0.102
Health region and ethnicity controls?	No	Yes	No	Yes	No	Yes
N	153,230		77,190		76,040	

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. The sample includes all youths aged 12–26 y in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for province/territory and for CCHS year, as well as quartic age controls. For the full sample, a dummy for female is also included. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level (13 clusters). The *p* values are provided for clustering at the province–age level (195 clusters) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province.
Source: Author's tabulations.

Table 3: Estimated Effect of Junk Food Bans (By Grouped Duration) on Youth BMI

	Full Sample		Males		Females	
Ban-years dummy: 1 y or less	−0.054	−0.0494	−0.011	0.00682	−0.099	−0.102
(cluster-robust SE [prov])	(0.062)	(0.0765)	(0.048)	(0.0592)	(0.113)	(0.1260)
Clustered *p* value (prov)	0.401	0.531	0.820	0.910	0.398	0.437
Clustered *p* value (prov–age)	0.382	0.421	0.901	0.938	0.244	0.249
Bootstrapped *p* value (prov)	0.474	0.590	0.776	0.958	0.504	0.582
Ban-years dummy: 1.5–4.5 y	−0.098	−0.112	−0.002	−0.0106	−0.191	−0.204
(cluster-robust SE [prov])	(0.079)	(0.0745)	(0.0996)	(0.0974)	(0.114)	(0.114)
Clustered *p* value (prov)	0.240	0.160	0.986	0.915	0.120	0.097
Clustered *p* value (prov–age)	0.092	0.066	0.982	0.891	0.017	0.017
Bootstrapped *p* value (prov)	0.282	0.250	0.936	0.880	0.252	0.234
Ban-years dummy: 5 y or more	−0.346	−0.387	−0.308	−0.341	−0.391	−0.424
(cluster-robust SE [prov])	(0.107)	(0.118)	(0.104)	(0.0960)	(0.155)	(0.181)
Clustered *p* value (prov)	0.007	0.006	0.012	0.004	0.026	0.037
Clustered *p* value (prov–age)	0.000	0.000	0.003	0.004	0.005	0.004
Bootstrapped *p* value (prov)	0.040	0.046	0.090	0.076	0.056	0.064
Health region and ethnicity controls?	No	Yes	No	Yes	No	Yes
N	153,230		77,190		76,040	

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Sample includes all youths aged 12–26 y in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for province–territory and for CCHS year, as well as quartic age controls. For the full sample, a dummy for female is also included. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (195 clusters) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province.
Source: Author's tabulations.

all cases, results are similar regardless of whether controls are included for the race/ethnicity of the student and fixed effects for the specific health region in which the student resides.

To allow for nonlinear effects of the policy variable, I separate the effects for those who have faced one year or less of a ban, 1.5–4.5 years of ban, and five or more years. Table 3 presents these results, in which each of these groups is controlled for using independent dummy variables. For the full sample, the point estimates grow in the expected manner, with the point estimate for those facing a ban for one year or less quite close to the linear point estimate in Table 2. However, the coefficients are not statistically significant until one examines students who have faced five or more years of ban. For this group, however, the coefficients suggest that for students who have been banned from junk food for five or more years, average BMI is decreased by about 0.35. These results are significant at the 1 percent level using the province–age clustered standard error and remain significant at the 5 percent level using the bootstrapping procedure.

Similar patterns are observed when stratifying the sample by sex, although results are, once again, somewhat stronger for females, in terms of both size of coefficients and their significance. In particular, point estimates are very close to zero for males facing less than five years of ban but are closer to the female estimates for those who have faced five or more years of ban. In all cases, results by gender for those having faced five or more years of ban are statistically significant at the 1 percent level when clustering at the province–age level and no worse than the 10 percent level once using the bootstrapping procedure.

Table 4 reports the results by age group. Although the point estimates for all groups are negative, the coefficients are only statistically significant for the youngest group of students (aged 12–15 y). This also holds true in Table 5, where the policy variable is replaced with three dummy variables depending on the duration of treatment. Once again, the results are insignificant for those aged older than 16 years. However, for those aged 12–15 years, coefficients for those treated for 1.5–4.5 years as well as those treated for 5 or more years are statistically significant, even after bootstrapping. The coefficients imply that students aged 12–15 years who are exposed to a school junk food ban for 1.5–4.5 years and 5 or more years have BMIs of 0.217 and about 0.33 less on average, respectively, than their peers who have not faced a ban.

The heterogeneous policy effect by age has at least two possible explanations. First, there are very few observations of older individuals who have had more than one or two years of treatment. This is simply due

Table 4: Estimated Effect of Junk Food Ban School Years on Youth BMI, By Age Group

	Aged 12–15 y		Aged 16–20 y		Aged 21–26 y	
Ban years coefficient	−0.061	−0.062	−0.012	−0.014	−0.031	−0.045
(cluster-robust SE [prov])	(0.018)	(0.025)	(0.017)	(0.016)	(0.050)	(0.048)
Clustered *p* value (prov)	0.005	0.030	0.480	0.382	0.543	0.368
Clustered *p* value (prov–age)	0.009	0.031	0.536	0.500	0.613	0.443
Bootstrapped *p* value (prov)	0.006	0.078	0.494	0.390	0.686	0.424
Health region and ethnicity controls?	No	Yes	No	Yes	No	Yes
N	41,290		58,190		53,750	

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Sample includes all youths by age group indicated in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for female, province–territory, and CCHS year, as well as quartic age controls. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (52, 65, and 78 clusters, respectively) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province.
Source: Author's tabulations.

Table 5: Estimated Effect of Junk Food Bans (By Grouped Duration) on Youth BMI, by Age Group

	Ages 12–15 y		Ages 16–20 y		Ages 21–26 y	
Ban-years dummy: ≤1 y	−0.118	−0.0954	−0.0119	0.0253	0.0075	−0.0657
(cluster-robust SE [prov])	(0.096)	(0.075)	(0.055)	(0.075)	(0.157)	(0.178)
Clustered *p* value (prov)	0.243	0.225	0.831	0.742	0.963	0.718
Clustered *p* value (prov–age)	0.306	0.362	0.873	0.742	0.948	0.580
Bootstrapped *p* value (prov)	0.370	0.334	0.882	0.744	0.906	0.836
Ban-years dummy: 1.5–4.5 y	−0.217	−0.217	0.0174	0.0234	−0.0706	−0.0861
(cluster-robust SE [prov])	(0.064)	(0.078)	(0.079)	(0.065)	(0.109)	(0.092)
Clustered *p* value (prov)	0.005	0.016	0.828	0.724	0.530	0.370
Clustered *p* value (prov–age)	0.015	0.026	0.828	0.777	0.689	0.632
Bootstrapped *p* value (prov)	0.020	0.058	0.904	0.786	0.616	0.490
Ban-years dummy: ≥5 y	−0.342	−0.323	−0.137	−0.155	−0.808	−0.936
(cluster-robust SE [prov])	(0.120)	(0.152)	(0.088)	(0.104)	(0.475)	(0.387)
Clustered *p* value (prov)	0.015	0.055	0.148	0.161	0.114	0.032
Clustered *p* value (prov–age)	0.013	0.052	0.314	0.300	0.079	0.015
Bootstrapped *p* value (prov)	0.012	0.104	0.154	0.106	0.292	0.274
Health region and ethnicity controls?	No	Yes	No	Yes	No	Yes
N	41,290		58,190		53,750	

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Sample includes all youths by age group indicated in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for female, province–territory, and CCHS year, as well as quartic age controls. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (52, 65, and 78 clusters, respectively) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province.
Source: Author's tabulations.

to the fact that most of the older students in the sample had graduated before (or just after) the implementation of most bans and were thus not affected. Supporting this explanation are the large standard errors for the eldest age grouping for those affected by five or more years of ban. In summary, this explanation suggests that, in reality, there is a similar effect for older students, but it cannot be observed with precision because of small sample size.

An alternative explanation for the heterogeneous effects by age is that the older students are indeed affected at the time of the junk food ban, but put weight back on after graduation. Note that because students graduated high school at around age 18 years, the entire youngest group is still in high school (and thus still facing a junk food ban) at the time of observation, and the eldest group has been graduated for 3–8 years. Many of the eldest group have therefore continued on to postsecondary education, where stories of rapid weight gain are common.[13]

A final potential explanation is that the youngest students, especially those too young to drive a car, are the least able to leave school property during school breaks. This might suggest that they are less likely to be able to purchase junk food off of school property and might be those most likely to either forgo the snack entirely or replace it with a healthier snack purchased at the school.

Falsification and Sensitivity Tests

Tables 6 and 7 contain the results of both a robustness check and a falsification test. As a robustness check, I replace the dependent variable BMI with BMI *z* score,

Table 6: Estimated Effect of Junk Food Ban School Years on Alternate Outcomes

	Dependent Variable: BMI z Score			Dependent Variable: Height		
	Full Sample	Males	Females	Full Sample	Males	Females
Ban years coefficient	−0.0118	−0.00944	−0.0144	−0.0005	−0.0007	0.00004
(cluster-robust SE [prov])	(0.004)	(0.005)	(0.006)	(0.0003)	(0.0005)	(0.0004)
Clustered *p* value (prov)	0.016	0.086	0.033	0.203	0.174	0.930
Clustered *p* value (prov–age)	0.001	0.019	0.005	0.148	0.097	0.916
Bootstrapped *p* value (prov)	0.050	0.154	0.102	0.246	0.216	0.932
Health region and ethnicity controls?	No	No	No	No	No	No
N	153,230	77,190	76,040	158,500	78,240	80,260

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10 Sample includes all youths aged 12 to 26 y in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for province–territory and for CCHS year, as well as quartic age controls. For the full sample, a dummy for female is also included. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (195 clusters) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province–territory.
Source: Author's tabulations.

Table 7: Estimated Effect of Junk Food Bans (By Grouped Duration) on Alternate Outcomes

	Dependent Variable: BMI z Score			Dependent Variable: Height		
	Full Sample	Males	Females	Full Sample	Males	Females
Ban-years dummy: ≤1 y	−0.0179	−0.00524	−0.0314	−0.0013	−0.00230	−0.00001
(cluster-robust SE [prov])	(0.0127)	(0.0113)	(0.0236)	(0.0009)	(0.0010)	(0.0009)
Clustered *p* value (prov)	0.186	0.652	0.208	0.173	0.041	0.982
Clustered *p* value (prov–age)	0.237	0.811	0.124	0.314	0.193	0.988
Bootstrapped *p* value (prov)	0.272	0.598	0.324	0.274	0.140	0.972
Ban-years dummy: 1.5–4.5 y	−0.0278	−0.00631	−0.0503	−0.00179	−0.00236	−0.0002
(cluster-robust SE [prov])	(0.0182)	(0.0252)	(0.0225)	(0.0011)	(0.0020)	(0.0007)
Clustered *p* value (prov)	0.153	0.806	0.045	0.136	0.253	0.789
Clustered *p* value (prov–age)	0.052	0.728	0.009	0.110	0.177	0.877
Bootstrapped *p* value (prov)	0.248	0.792	0.166	0.116	0.322	0.734
Ban-years dummy: ≥ 5 y	−0.0843	−0.0813	−0.0888	−0.00289	−0.00675	0.00164
(cluster-robust SE [prov])	(0.0241)	(0.0250)	(0.0355)	(0.0023)	(0.0036)	(0.0030)
Clustered *p* value (prov)	0.004	0.007	0.028	0.235	0.083	0.596
Clustered *p* value (prov–age)	0.000	0.001	0.012	0.192	0.020	0.540
Bootstrapped *p* value (prov)	0.026	0.084	0.066	0.272	0.136	0.750
Health region and ethnicity controls?	No	No	No	No	No	No
N	153,240	77,190	76,040	158,500	78,240	80,260

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Sample includes all youths aged 12–26 y in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for province–territory and for CCHS year, as well as quartic age controls. For the full sample, a dummy for female is also included. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (195 clusters) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province–territory.
Source: Author's tabulations.

Table 8: Estimated Effect of Years before Ban on Youth BMI

	Dependent Variable: BMI With Linear Ban Years			Dependent Variable: BMI With Grouped Ban Years		
	Full Sample	Males	Females	Full Sample	Males	Females
Years to ban coefficient	0.0275	−0.00623	0.0626	0.0287	−0.00266	0.0616
(cluster-robust SE [prov])	(0.0360)	(0.0374)	(0.0370)	(0.0382)	(0.0373)	(0.0414)
Clustered *p* value (prov)	0.460	0.870	0.117	0.467	0.944	0.162
Clustered *p* value (prov–age)	0.159	0.822	0.012	0.162	0.927	0.018
Bootstrapped *p* value (prov)	0.548	0.924	0.122	0.554	0.986	0.200
Health region and ethnicity controls?	No	No	No	No	No	No
N	153,230	77,195	76,035	153,230	77,195	76,035

Notes: As per requirements of the Research Data Center, unweighted frequencies (sample sizes) have been rounded to the nearest 10. Sample includes all youths aged 12–26 y in the CCHS for 2000, 2003, 2005, and 2007–2013. I include dummies for province–territory and for CCHS year, as well as quartic age controls. For the full sample, a dummy for female is also included. Fixed effects for health region and ethnicity controls are added where indicated. Standard errors are robust to clustering at the provincial level. *p* values are provided for clustering at the province–age level (195 clusters) and the provincial level (13 clusters bootstrapped using the Wild bootstrap procedure, as described in Cameron et al. 2008). BMI = body mass index; CCHS = Canada Community Health Survey; prov = province–territory.

created using the means and standard deviations for each age–sex group. There are no qualitative differences in findings using BMI *z* score: The overall policy variable remains weakly significant for the full sample, and the categorical policy variables are strongly statistically significant for both genders.

As a first falsification test, I replace the dependent variable, BMI, with the individual's height in metres. Because height is not plausibly affected by a ban on junk food, a correlation between the policy variable and height implies a problem with the specification of the model. However, the policy variable is not correlated with height in a statistically significant way. Naturally, these results do not prove the validity of the model because a failure to reject the null does not prove the null. Nevertheless, the falsification test provides no evidence against the validity of the model and is consistent with the identifying assumptions.

As a second falsification test, I check for pre-existing trends for the students affected by junk food bans. I therefore create a "years-to-ban" variable that measures the number of years left before a student will face a ban. For example, the Ontario junk food ban came into effect in September 2011, and the 2012 CCHS was therefore the first year in which the regular policy variable was positive. In the 2011 CCHS, the years-to-ban variable is set to one for those Ontario students who will still be in elementary or high school the following year; in 2010, the variable is set to two.

Table 8 presents the results of this second falsification test. In no case is the coefficient of the years-to-ban variable statistically significant, providing no significant evidence of a pre-existing trend. For boys, the estimated coefficient is very close to zero, providing no evidence at all of such a trend. For girls, however, although the point estimate is not statistically significant once bootstrapped, it is high enough to suggest a pre-existing trend toward decreasing BMI. Nevertheless, estimates of the actual policy variables (not shown) for both genders remain very close to those reported in Tables 2 and 3, suggesting that the policy continues to have negative impact on BMI.

Discussion and Conclusion

This article investigates the impact of provincewide bans on the sale of junk food in schools (the treatment) on the BMI of Canadians aged 12–26 years over 2000–2013. I use a difference-in-differences estimator to exploit the differences in policy timing across provinces and differences in treatment duration across youths of different ages within provinces.

The study has three main advantages when compared with others of its kind. First, the intervention is large enough to reasonably expect to observe results: All elementary and high school students within a province are treated; the treatment takes place for the entire school day, each and every school day; and observed students have been treated for as long as 8 school years. Second, the fact that there is substantial variation in the policy variable (depending on the student's age and province, treatment duration varies between 0.5 and 8 school years) helps with identification relative to typical difference-in-differences estimates that rely on zero–one policy variables. Third, I use a large, nationally representative survey data set with a total of more than 153,000 observations (22,000 treated) over 10 years—enough that, should policy effects exist, one could reasonably expect to see them.

As with any study relying on policy changes over time for identification, certain assumptions are required to believe in a causal interpretation of the results. First, one must believe that the trend over time in student BMI would have been the same in the provinces with junk food bans as in those without them. It is true that provinces have implemented other approaches to combating childhood obesity over the study period. However, sensitivity tests involving years-before-ban variables provide some confidence that it was not that provinces were effectively combating obesity and then implemented junk food bans. Second, if it were the case that provinces implemented junk food bans as one part of a multipronged program to fight obesity, it would be difficult to separately identify the impact of junk food bans from that of other programs implemented at the same time. In practice, to my knowledge the only province to directly tie its junk food ban to another childhood obesity policy was British Columbia, which required 30 minutes of daily physical activity at the same time as it implemented its junk food ban (see Appendix 1).

I find that each year that a student is banned from purchasing junk food at school is associated with a decline in average BMI of about 0.05 kilograms per metre squared. However, this overall finding is only weakly statistically significant once standard errors are corrected using the wild bootstrap procedure. When focusing on those students who have been banned from purchasing junk food for a period of five or more years, however, I find that these students have an average BMI about 0.35 kilograms per metre squared lower than their peers who have not undergone any treatment. These results are consistently statistically significant.

In my sample, the results are stronger for the youngest age group, those aged 12–15 years (the CCHS samples individuals aged 12 y and older). This may simply be a result of the fact that few of the older individuals were subjected to treatment of more than 1 or 2 years, because they are more likely to have graduated before the implementation of the policy. However, the lack of results for older individuals could also be attributable to the fact that they have graduated and left treatment and may therefore have put back on any weight lost.

Results are also usually stronger, in terms of both size of coefficient and statistical significance, for females than for males. This makes for an interesting contrast to the results of Cawley, Frisvold, and Meyerhoefer (2013), who find that state requirements of the minimum number of minutes of physical education has a stronger impact on decreasing the weight of boys.

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Notes

1 Cawley (2015, 244) summarizes a number of potential economic causes of obesity, including "the monetary price and time cost of food, food assistance programs, income, education, macroeconomic conditions, and peer effects," and finds that "there is no single dominant economic cause of obesity."

2 Cawley, Meyerhoefer, and Newhouse (2007), Cawley et al. (2013), and Sabia, Nguyen, and Rosenberg (2016) each study the impacts of state minimum requirements for physical education on student physical activity and weight outcomes. Only Cawley et al. (2013), however, find significant impacts on student weight, and they find impacts only for boys.

3 Multiple studies examine the link among school food environment, student food choices, and student health outcomes. Currie et al. (2010) show that a new fast food restaurant located near a school results in an increased probability of weight gain for ninth-grade students. Grainger, Senauer, and Runge (2007) find that the National School Lunch Program in the United States is associated with an improvement in the nutritional quality of students' food choices, and Ishdorj, Crepinsek, and Jensen (2013) find that specific policies of the National School Lunch Program had an impact on student eating habits both at the school and at home. Millimet, Tchernis, and Husain (2010) find that the School Breakfast Program improves obesity outcomes, whereas the National School Lunch Program exacerbates the problem. Taber et al. (2013) compare states that exceed US Department of Agriculture school meal standards with those that do not. They find that the difference in obesity prevalence between students who obtained free or reduced-price lunches and students who did not obtain school lunches was smaller in states that exceed the department's meal standards. Powell (2009) finds that the weight of lower- to middle-income teens is more sensitive to fast food prices than that of upper-income teens. Mandal and Powell (2014) document the association between food choices and regulated child care settings in addition to the association between likelihood of obesity and consumption of sugary drinks. Anderson et al. (2011) use differences in school starting ages to measure the overall impact of school attendance on student weight outcomes and find declines in weight for those students who spent little time in child care before kindergarten. Elliott (2008) documents how unhealthy, "fun" foods are deliberately marketed to children in

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supermarkets, and Elliott (2012) shows how foods marketed to children as "better for you" are in fact more about marketing than about nutrition.

4 This variation in treatment intensity addresses one of the criticisms by Bertrand et al. (2004) of standard difference-in-differences methodologies, which typically use a binary policy variable.

5 In all cases, I include only bans that are mandatory at the provincial level. In the case of Prince Edward Island, the two English School Districts implemented bans beginning in summer 2005, and the single French School Board implemented its ban in February 2006. Because I cannot observe which students attend the French Board, and because they are only a small fraction of all students in Prince Edward Island, I treat it as though a single ban were imposed in the 2005/06 school year. There may be the odd school board that has implemented a similar policy independently from its province. For example, the Edmonton School Board (in Alberta) implemented a ban in 2011. Dropping the Edmonton area observations in the final two survey years slightly strengthens the significance of the policy variable. All regressions in the tables include these observations (with a zero recorded as a policy variable).

6 The 2000 data were collected from 1 September 2000 to 1 November 2001. Data in all other years were collected between January and December of the survey year. Because I control for survey-year dummy variables in all regressions (and because no junk food bans began until 2005), the fact that the first year of data follows a different sampling scheme makes little practical difference.

7 The CCHS does not compute a BMI for those who report being taller than seven feet or shorter than three feet in height. A valid BMI is calculated for approximately 94 percent of all survey respondents.

8 Note, the methodology does not require that the initial average BMI in treated and non-treated provinces be similar, only that the changes over time be common. If this is the case, then the initial differences are accounted for as a group fixed effect.

9 Although most bans begin at the beginning of a school year, a few begin in January. I count bans beginning in January (or February) as 0.5 of a school year of treatment.

10 Appendix 2 provides tables that indicate for New Brunswick the number of years of ban faced by each age group in 2014 for each province and for each survey year.

11 As long as the age function is at least a quadratic, the functional form makes no difference to the results. I use a quartic to allow complete flexibility.

12 See Appendix 2 for more details on the policy variable.

13 See, for example, D.A. Anderson, Shapiro, and Lundgren (2003) for empirical measures of the existence of the "freshman 15."

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Appendix 1
Provincial and Territorial Junk Food Policies

Province or Territory	Policy	Date of Implementation	Notes
NB	Yes	11 October 2005, updated March 2008	Banned all food from minimum nutrition list
NS	Yes	January 2007 (phased in starting 2004)	Ban of deep fryers, sugary drinks, foods from minimum nutrition list
PE	Yes, by board (but all boards have something)	Eastern School Board—2005. Superseded by 2011 policy	"Foods should rarely come from *Food to Serve Least Often*"; energy drinks banned from school property
		Western School Board—June 2005 (revised 2010)	Same details as Eastern School Board
		French School Board—February 2006	Chips, candy, and sugary drinks cannot be sold; weekly menu may have a maximum of two of chicken fingers or burgers, fish sticks, garlic fingers, nachos, salami, pepperoni, bologna, hot dogs, French fries, or poutine
NL	No; see notes		General policy (fall 2006) to increase healthy foods and discourage unhealthy food, but no specific ban; some schools may have bans
QC	Yes	Announcement September 2007; January 2008 implementation	
ON	Yes	September 2011	
MB	No		
SK	No		No provincial policy, but individual boards may have policies
AB	No; see notes		Some school boards (Edmonton, September 2012)
BC	Yes	January 2008 (elementary) September 2008 (middle and high school)	Combined with requirement of 30 min/d physical activity
YT	No		
NW.	No		
NT	No		

Source: Author's compilation.

Appendix 2
School Years of Junk Food Ban

Table B.1: Ban Years by Age and Year for New Brunswick

Age (y)	2000	2003	2005	2007	2008	2009	2010	2011	2012	2013
26	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	0	1	2
23	0	0	0	0	0	0	0	1	2	3
22	0	0	0	0	0	0	1	2	3	4
21	0	0	0	0	0	1	2	3	4	5
20	0	0	0	0	1	2	3	4	5	6
19	0	0	0	1	2	3	4	5	6	7
18	0	0	0	2	3	4	5	6	7	8
17	0	0	0	2	3	4	5	6	7	8
16	0	0	0	2	3	4	5	6	7	8
15	0	0	0	2	3	4	5	6	7	8
14	0	0	0	2	3	4	5	6	7	8
13	0	0	0	2	3	4	5	6	7	8
12	0	0	0	2	3	4	5	6	7	7

Note: Data indicate the number of school years banned from junk food purchases assigned to students of each age for each CCHS year in New Brunswick. Because the policy was implemented at the beginning of the 2005/06 school year, CCHS 2007 is the first survey year in which treated students can be observed. By 2013, the policy has been in place for eight school years, so the maximum number for the ban-years variable is eight for students aged 13–18 y, who were in elementary or high school for each year of the ban. CCHS = Canada Community Health Survey.
Source: Author's calculations.

Table B.2: Assigned Number of Ban Years by Age and Province in the Final Year of the Canada Community Health Survey—2013

Age (y)	ON	NB	PE	BC	NS	QC	Others
26	0	0	0	0	0	0	0
25	0	1	1	0	0	0	0
24	0	2	2	0	0.5	0	0
23	0	3	3	0	1.5	0.5	0
22	0	4	4	1	2.5	1.5	0
21	0	5	5	2	3.5	2.5	0
20	0	6	6	3	4.5	3.5	0
19	1	7	7	4.5	5.5	4.5	0
18	2	8	8	5.5	6.5	5.5	0
17	2	8	8	5.5	6.5	5.5	0
16	2	8	8	5.5	6.5	5.5	0
15	2	8	8	5.5	6.5	5.5	0
14	2	8	8	5.5	6.5	5.5	0
13	2	8	8	5.5	6.5	5.5	0
12	2	7	7	5.5	6.5	5.5	0

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Appendix 3
Body Mass Index

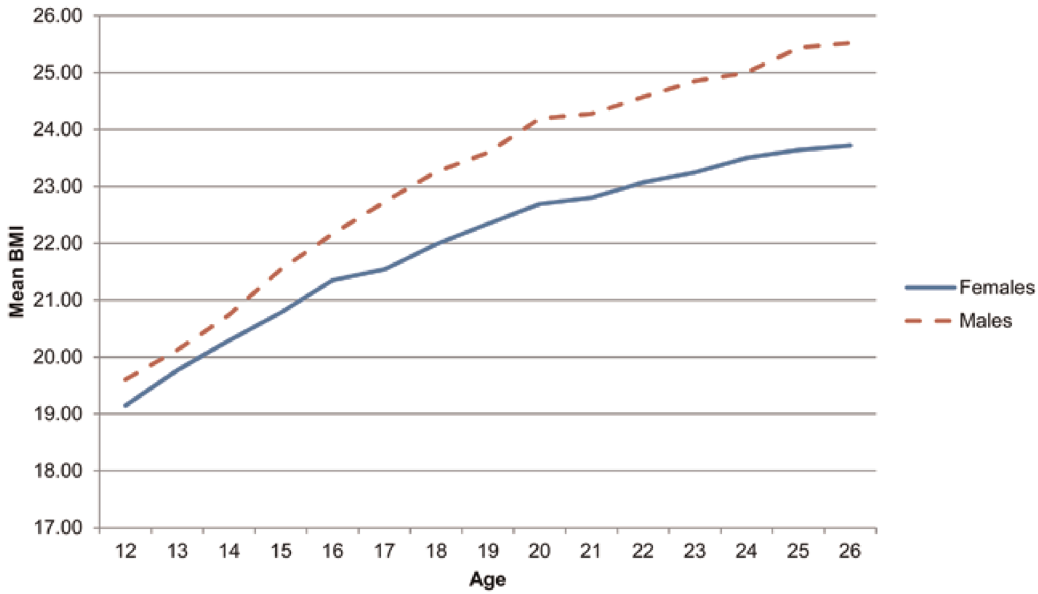

Figure C.1: Average BMI by Age and Gender.
Note: BMI = body mass index.
Source: Author's tabulations based on pooled Canada Community Health Survey cross-sections.

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