The contribution of excise cigarette taxes on the decline in youth smoking in Canada during the time of the Federal Tobacco Control Strategy (2002–2012)

Phongsack Manivong, PhD,[1] Sam Harper, PhD,[1] Erin Strumpf, PhD[1,2]

ABSTRACT

OBJECTIVES: To evaluate the impact of changes in cigarette taxes on smoking for youths aged 15–18 in Canada during the time of the Federal Tobacco Control Strategy (FTCS).

METHODS: We used a difference-in-differences framework and leveraged the variation in cigarette taxes across Canada and over time. We used regression models with province and year fixed effects, and individual-level and provincial-level covariates on 2002–2012 data from the Canadian Tobacco Use Monitoring Survey.

RESULTS: Tax increases generally did not affect smoking outcomes. Each increase of CAD $1.00 (adjusted to year 2000 dollars) in excise cigarette taxes per package of 20 was associated with a 0.2 percentage point (95% CI: −1.8; 2.2) change in smoking prevalence, and a change of 0.3 in mean cigarettes smoked in the past week (95% CI: −1.2; 1.8).

CONCLUSION: From 2002 to 2012, smoking prevalence and mean smoking frequency were in steady decline among youths in Canada. This decline, however, was evident even among provinces with stable or decreasing cigarette tax levels. Tobacco taxes have mostly increased since the 1980s, and so, tax levels were already quite high by the launch of the FTCS. Province fixed effects and common temporal changes accounted for 83.7% of the variation in smoking prevalence. We derived similar results for smoking frequency. The cumulative tax increase during our study period was at least $1.00 for only three provinces. Thus, our findings suggest that factors driving down tobacco use among youths in all provinces appear to outweigh any impact of small tax increases at already high tax levels.

KEY WORDS: Tobacco; taxes; adolescent; smoking; Canada

La traduction du résumé se trouve à la fin de l'article.

Can J Public Health 2017;108(2):e117–e123
doi: 10.17269/CJPH.108.5705

Since the turn of the 21st century, tobacco consumption has slowly declined among youths in Canada. During this time, various forms of tobacco control have been implemented at both the federal and provincial levels. For example, the Federal Tobacco Control Strategy (FTCS) was a 10-year initiative launched in 2001 by a consortium led by Health Canada and Public Health Agency of Canada to reduce tobacco consumption.[1] Two key components were the promotion of smoke-free laws and the enforcement of the Tobacco Act, which includes restrictions on the manufacture, sale, access and promotion of tobacco products.[2]

One key tobacco control strategy cited by public health agencies as an important determinant of smoking is excise taxes. A working group of experts across various disciplines assembled together for The International Agency for Research on Cancer (IARC) to summarize the body of literature on tobacco control policies and their effectiveness.[3] The working group deemed that there was sufficient evidence for the following conclusions regarding the effect of tobacco taxes on youth smoking habits: 1) tobacco taxes reduce the prevalence of tobacco use among youth, and 2) tobacco taxes reduce the development of regular tobacco use.

In order for excise taxes to be effective, it is generally the case that smokers do not engage in price-reducing strategies and that tax increases are frequent and substantially large enough to counteract general price and income inflation.[4] In Canada, tobacco taxes are implemented at both the federal and provincial levels. In recent years, nominal tobacco tax levels have primarily increased at the provincial level.[5,6]

Although there is much research on the effects of taxes and prices on youth smoking, previous studies cannot identify their impact during the time of the FTCS.[7–10] A commonly reported measure of effect is price or tax elasticity, which is the percentage change in smoking given a percentage change in price or taxes. Elasticity estimates, however, are sensitive to the study population, time frame, price/tax range, and specifications of price and demand.[11] The Canadian tobacco control environment has changed since previous studies were conducted, when tobacco taxes were the predominant form of tobacco control and levels were much lower.

Author Affiliations

1. Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, QC
2. Department of Economics, McGill University, Montreal, QC

Correspondence: Phongsack Manivong, PhD, Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Purvis Hall, 1020 Pine Avenue West, Montreal, QC H3A 1A2, Tel: 514-398-6258, E-mail: Phongsack.Manivong@mail.mcgill.ca

Statement of Funding: This study was supported by an operating grant TO3-120314 from the Canadian Institutes of Health Research.

Conflict of Interest: None to declare.

During the FTCS, tobacco taxes had to work in conjunction with other forms of tobacco control such as the Tobacco Act and health warnings on cigarette packages.[5,12–15]

A second limitation in observing the effect of tax or price changes on smoking in international studies and making inferences with regard to a Canadian setting is that tobacco tax levels and tobacco control policies can vary between Canada and other countries.[12] A third limitation is the use of *average* annual provincial prices or taxes as the policy variable. One disadvantage of this approach is that changes often occur within the year, and this could cause a bias towards the null as the same price or tax level is assigned to a population before and after a tax increase. Finally, other studies have often included both youths and adults within the same study. Youths, particularly those under 18 years of age, and adults can respond differently to cigarette taxes, as youths do not have the same monetary resources as adults and they are not of legal age to purchase cigarettes. Furthermore, the effect of tobacco control on youths and adults has different implications.[3] For youths, the effect of taxes is the impact on smoking initiation and habit development; while for adults, the effect is the impact on smoking cessation and reduction.

In summary, it is not possible to extend the results from previous studies in order to understand the impact of recent increases in excise cigarette taxes on youth smoking in Canada during the time of the FTCS. In this study, we evaluated how recent increases in cigarette taxes have influenced the prevalence and frequency of youth smoking from 2002 to 2012.

METHODS

Data and measures

We obtained data on smoking-related outcomes, education and other demographic variables from the Canadian Tobacco Use Monitoring Survey (CTUMS). CTUMS also contained the year and month of the interview, which allowed for a more precise assignment of cigarette tax levels to each individual at the time of survey.

CTUMS was launched in 1999 in order to monitor smoking trends in Canada (excluding the territories), particularly among the most at-risk group to develop a habit, namely those aged 15–24.[16] It is a population-weighted, multi-stage, cross-sectional survey conducted semi-annually by telephone. We used data from the years 2002 to 2012. The cumulative sample size for the 11 years of data was about 229 000. The target population of our study were youths aged 15–18. After the age exclusion, the potential sample size for our study was 49 172 participants.

Individual-level data of interest included education, age (years), sex, language (spoken at home) and household size. We used indicator variables for age, with 15 as the reference, as well as for gender (*female* as reference). Language contained the following categories: *English* (reference), *French*, *English & French*, and *Other*. Household size was a categorical variable with *1* (reference), *2*, *3*, *4* and *5 or more* as options. Education was a derived variable consisting of four distinct categories: *High school not completed & not current student* (reference), *High school not completed but current student*, *High school graduate & not current student*, and *High school graduate & current student*.

We considered two smoking-related outcomes: past-week smoking status and smoking frequency. CTUMS first identifies whether a participant smoked within the past 30 days, and among smokers, the number of cigarettes smoked within the previous 7-day period. Past-week cigarette quantity was set to 0 if the participant did not report smoking within the past 30 days.

Data on excise cigarette tax levels and their corresponding effective dates were extracted from the Finances of the Nation 2002–2012 reports provided by the Canadian Tax Foundation.[6] Cigarette taxes were reported for a carton of 200 cigarettes, which we converted to taxes for a typical package of 20 cigarettes.[17,18] Although both federal and provincial governments imposed excise taxes on cigarettes, from 2002 to 2012 virtually all tax changes were at the provincial level. Additionally, during this time there were only nominal increases to excise cigarette taxes. Supplementary Appendix A (see ARTICLE TOOLS section on journal site for all supplementary appendices files mentioned in this article) contains details on the changes and timing of federal and provincial excise tax levels, including tables with means of nominal annual tax levels, means of CPI-adjusted annual tax levels and annual CPI values by province.

To account for inflation, we standardized nominal tax changes to year 2000 dollars by the Canadian Consumer Price Index (CPI) of general goods.[4] Data on the CPI of general goods were extracted from the Canadian Socio-economic Information Management system (CANSIM), Statistics Canada's online database.[19,20] Our method to adjust cigarette tax levels by the CPI followed that of Azagba and Sharaf (2011).[10]

Figure 1 shows cumulative nominal and CPI-adjusted cigarette tax levels by province and year. A flat curve or line for CPI-adjusted cigarette tax levels would indicate that increases in cigarette taxes did not outpace increases in the price of general goods. Note that the absolute range in nominal tax levels was approximately \$3.00–\$7.00, while the range for CPI-adjusted cigarette tax levels was \$3.00–\$5.00, and that most year-to-year increases were less than \$1.00. It is also important to note that some provinces experienced gradual increases in CPI-adjusted cigarette tax levels, whereas others actually had nominal increases that failed to keep up with inflation, leading to slight decreases in real cigarette tax levels over this period. Relative to 2002, Prince Edward Island implemented the greatest increase in cigarette taxes, reaching \$1.58 per pack of 20 by 2012. Conversely, Quebec observed the greatest decrease in cigarette tax levels of \$0.18 per pack of 20 by 2012.

We considered three potential provincial-level confounders in our study. These are factors that affect smoking and whose implementation or changes may have coincided with changes in cigarette tax levels during the time of the FTCS. We included two other tobacco control strategies where implementation varied by province, namely smoke-free laws and retail tobacco display bans. The main source of provincial smoke-free laws was the report, *Provincial and Territorial Smoke-Free Legislation Summary*.[13] Data on tobacco retail display bans were extracted from a Canadian Centre for Health Economics working paper.[21] For retail tobacco display bans, we created a binary variable to indicate a ban in effect in each province at time of interview. Similarly, for provincial smoke-free laws, we created a binary variable to indicate a law in effect in each province at time of interview based on the date of first

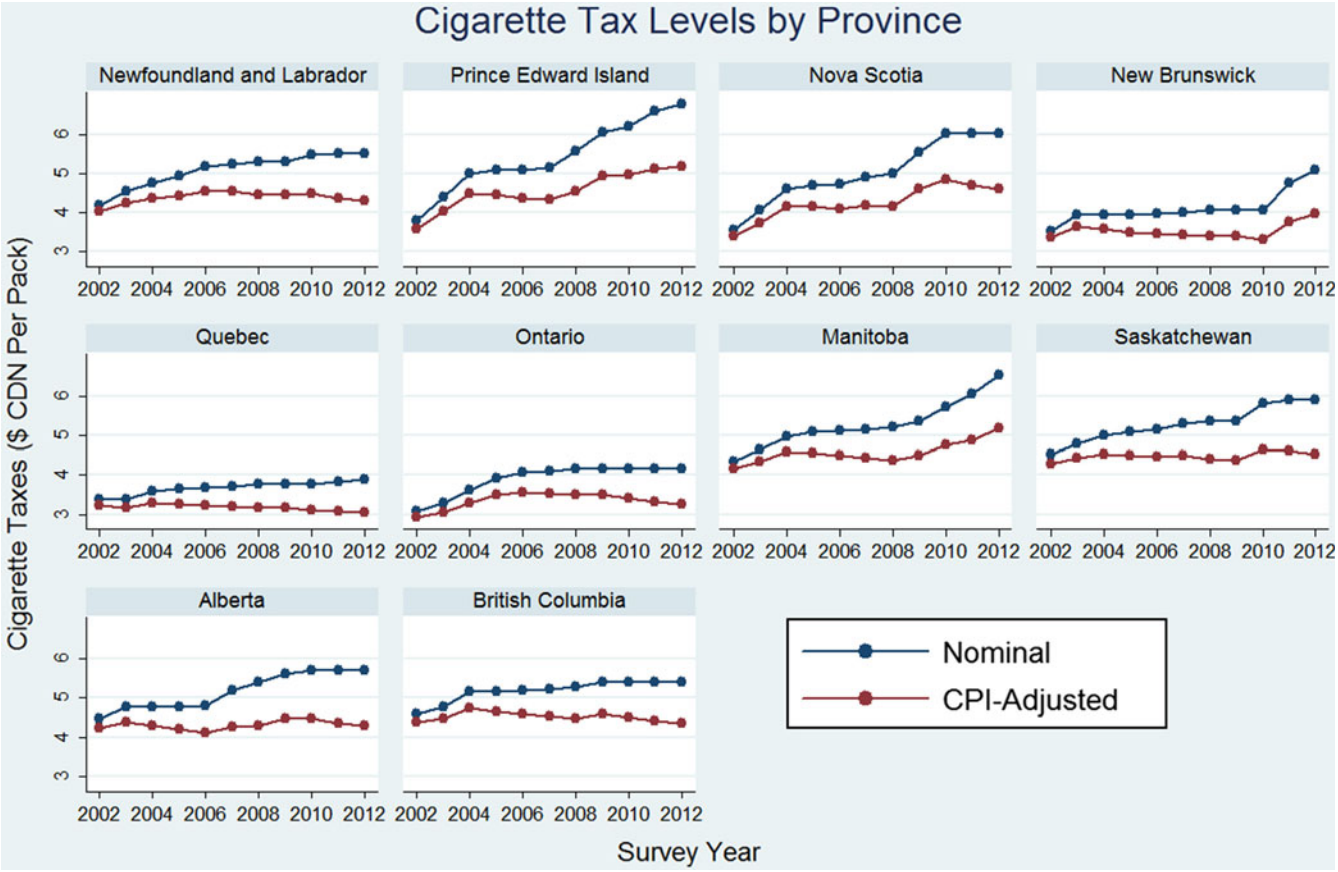

Figure 1. Means of cigarette tax levels, based on Finances of the Nation 2002–2012 reports[6]

implementation. To account for the potential effect of unemployment, we included rates based on those aged 15–19.[10,17] (Rates for the age range of 15–18 were not available.) Data on the Labour Force Survey estimates of unemployment rates were extracted from the CANSIM.[19,20] See Supplementary Appendix B for details on changes to these provincial-level factors over time.

Analytical plan

We used a series of difference-in-differences (DD) regression models to estimate the impact of tax changes on our smoking outcomes. Let Y_{ips} be a smoking-related outcome for individual i, in province p, survey year s, and let T_{ps} be the corresponding cumulative amount of excise cigarette taxes. The expectation (or mean) of Y_{ips} then becomes,

$$E(Y_{ips}) = \beta_0 + \beta_1 T_{ps} + \sum_{\forall p} \beta_p P_p + \sum_{\forall s} \beta_s S_s + \sum_{\forall c} \beta_c X_{c_{ips}} + \sum_{\forall k} \beta_k Z_{k_{ps}} \quad (1)$$

where β_p and β_s are coefficients denoting province and year fixed effects respectively. Both province and year effects were modeled with a series of binary dummies. Fixed effects for province account for all time-invariant provincial-level differences in the smoking-related outcomes. Fixed effects for year account for trends in smoking over time that may be driven by shared factors or federal policies that affect all provinces, such as graphic warning labels. The term X_c denotes individual-level covariates, and Z_k denotes time-varying provincial-level characteristics as described in the previous section.

We modeled smoking status using logistic regression and used marginal effects to estimate the effect of taxes on the additive scale. To model smoking frequency, we used a two-part model where a binary component for smoking status is modeled in the first stage with logistic regression and a frequency component in the second stage with Poisson regression.[22] To assess the contribution of changes in cigarette tax levels on smoking on the additive scale, we computed marginal effect estimates for an increase of $1.00 (per package) for both smoking outcomes, which are predicted counterfactual outcomes based on observed values for all other covariates. Marginal effects from the two-part model account for the average impact on smoking frequency, accounting for the proportion of non-smokers in the population.[23] To compare with other studies, we also calculated tax elasticity estimates (a relative effect measure).

Our analytical structure followed that of DeCicca and McLeod (2008).[17] We assessed the effect of cigarette taxes on each smoking outcome using three regression models. *Model 1* included fixed effects for province and year (the basic DD model). *Model 2* included individual-level covariates. *Model 3* additionally included provincial-level covariates.

Data extraction and data management were performed using SAS 9.3 and Stata/MP 12.1. All statistical analyses were performed

using Stata/MP 12.1. All estimates were derived using survey weights.[24] Standard errors (SEs) and 95% confidence intervals (CIs) were computed using bootstrap sampling.[25] Unless stated otherwise, we used the set of 200 bootstrap weights provided by CTUMS, as recommended by Statistics Canada for use of their survey data.[26]

To assess the robustness of our results, we performed eight different sensitivity analyses based on *Model 3*. The first considered the potential for non-linear effects of tax changes by assessing incremental dollar increases that span the range of our study ($3.00–$5.00). The second used the Probit model, more commonly found in the literature on taxation and price on smoking. Third, for smoking status, we substituted past-week smoker status with current smoker status. The fourth set pertained only to the smoking frequency outcome. Here, we used a negative-binomial distribution instead of a Poisson distribution to relax the mean-variance equality assumption. For the fifth set, we estimated robust standard errors with and without clustering by province in order to compare with the bootstrap sampling method. For the sixth type, we allowed for the possibility of heterogeneous effects by sex. For the seventh type, we excluded one province at a time to assess whether tax changes for a particular province were influencing our estimates. Similarly, for the last sensitivity analysis, we incrementally included a year of data to determine whether tax changes for a particular year had a significant impact on smoking.

RESULTS

Table 1 shows the key demographic characteristics of the 2002–2012 CTUMS sample, ages 15–18. Estimates represent sample percentages except for Past-week Cigarette Quantity where the mean is provided among smokers.

Table 2 provides estimates of the marginal effect and elasticity of CPI-adjusted cigarette taxes on smoking prevalence and frequency. For both outcomes, the crude models suggested that taxes are inversely related to smoking, but including province and year fixed effects effectively reduced these correlations to zero. Estimates for *Model 1–Model 3* were similar for both outcomes, which suggests that after controlling for province and year fixed effects, including individual- and provincial-level covariates did not have much influence on the effect of cigarette taxes on smoking. Based on *Model 3*, the marginal effect for an increase of $1.00 per package on smoking prevalence was 0.2 (95% CI: −1.8; 2.2) percentage points. Similarly, the marginal effect for mean smoking frequency was 0.3 (95% CI: −1.2; 1.8) cigarettes per week. As increases in cigarette taxes were actually smaller than $1.00 for many provinces, expected changes in smoking would remain negligible for smaller increases. (See Supplementary Appendix C for marginal estimates of all other model covariates.) Additionally, the set of eight sensitivity analyses shows that main results are robust to all specifications. See Tables 3 and 4.

Table 1. CTUMS survey-weighted sample characteristics, ages 15–18

Characteristics	Estimate	95% CI
Sample size		49 172
Past-week smoker	10.8%	10.4%; 11.3%
Missing		896
Past-week cigarette quantity (smokers)	58.6	56.4; 60.8
Province		
Newfoundland and Labrador	1.5%	1.5%; 1.6%
Prince Edward Island	0.5%	0.5%; 0.5%
Nova Scotia	2.9%	2.8%; 2.9%
New Brunswick	2.2%	2.2%; 2.3%
Quebec	22.1%	21.8%; 22.4%
Ontario	39.2%	38.8%; 39.6%
Manitoba	4.0%	3.9%; 4.0%
Saskatchewan	3.5%	3.5%; 3.6%
Alberta	11.1%	10.9%; 11.2%
British Columbia	13.1%	12.8%; 13.3%
Survey year		
2002	8.8%	8.5%; 9.1%
2003	8.8%	8.6%; 9.0%
2004	8.9%	8.7%; 9.1%
2005	8.9%	8.7%; 9.1%
2006	9.2%	9.0%; 9.4%
2007	9.2%	9.0%; 9.4%
2008	9.4%	9.2%; 9.6%
2009	9.4%	9.2%; 9.6%
2010	9.3%	9.1%; 9.5%
2011	9.1%	8.9%; 9.4%
2012	9.1%	8.9%; 9.3%
Education-student status		
No high school and not current student	5.6%	5.3%; 6.0%
No high school and current student	68.3%	67.6%; 69.0%
High school graduate and not current student	7.3%	7.0%; 7.7%
High school graduate and current student	18.7%	18.2%; 19.3%
Missing		338
Male	51.4%	50.9%; 51.8%
Age (years)		
15	24.8%	24.1%; 25.5%
16	25.3%	24.6%; 26.0%
17	25.7%	25.1%; 26.4%
18	24.2%	23.6%; 24.9%
Language (spoken at home)		
English	70.8%	70.3%; 71.3%
French	19.4%	19.0%; 19.8%
English and French	0.6%	0.5%; 0.7%
Other	9.2%	8.8%; 9.7%
Missing		328
Household size		
1	0.6%	0.5%; 0.7%
2	6.1%	5.8%; 6.4%
3	20.7%	20.1%; 21.2%
4	39.0%	38.2%; 39.8%
5 or more	33.7%	32.9%; 34.5%
Missing		3

Note: Estimates represent sample percentages except for past-week cigarette quantity where the mean is provided among smokers.

DISCUSSION

In this section, we cover some limitations of our study and then discuss general implications of the effects of cigarette taxation on smoking among Canadian youth. First, using self-reported tobacco consumption may be a concern due to social desirability, specifically the misreporting of smoking behaviour. In order for this to cause a bias given our study design, the rate of misreporting would have to change over time and differentially across provinces. One might be concerned that increases in cigarette taxes can lead to the use of contraband products where those engaged in such activity are less likely to report their smoking habits. If increases in cigarette taxes do actually decrease smoking, then the under-reporting of smoking would likely exaggerate this effect, or in other words, bias our estimates away from the null. Our estimates, however, were null for the effect of cigarette taxes on both smoking outcomes.

Moreover, if changes in cigarette taxes were to have a lagged effect, provinces that have the greatest increase in cigarette taxes should also eventually experience the greatest decrease in cigarette

Table 2. Effect of CPI-adjusted cigarette taxes on smoking, ages 15–18

Outcome	Model	Marginal effect			Elasticity		
		Estimate	*p*-value	95% CI	Estimate	*p*-value	95% CI
Smoking prevalence	Crude	−0.7%	0.0422	−1.5%; 0.0%	−0.26	0.0388	−0.51; −0.01
	1: Province and year fixed effects	0.0%	0.9685	−2.1%; 2.0%	−0.02	0.9685	−0.74; 0.71
	2: Model 1 + individual covariates	0.1%	0.9127	−1.8%; 2.1%	0.04	0.9127	−0.70; 0.79
	3: Model 2 + provincial covariates	0.2%	0.8279	−1.8%; 2.2%	0.08	0.8279	−0.67; 0.84
Smoking frequency	Crude	−0.6	0.0284	−1.1; −0.1	−0.35	0.0257	−0.65; −0.04
	1: Province and year fixed effects	−0.1	0.9276	−1.6; 1.5	−0.04	0.9341	−1.01; 0.93
	2: Model 1 + individual covariates	0.1	0.8558	−1.3; 1.6	0.10	0.8441	−0.91; 1.11
	3: Model 2 + provincial covariates	0.3	0.7352	−1.2; 1.8	0.18	0.7332	−0.86; 1.22

CPI = Consumer Price Index.
Note: Marginal effect estimates represent the incremental (additive) change in cigarette consumption for a $1.00 increase in CPI-adjusted excise cigarette taxes. Elasticity estimates represent a (relative) percentage change in cigarette consumption given a 1% increase in CPI-adjusted excise cigarette taxes.

Table 3. Sensitivity analyses for the marginal effect of CPI-adjusted cigarette taxes on smoking prevalence

Sensitivity type	Estimate	*p*-value	95% CI
Preferred model (model 3)	0.2%	0.8279	−1.8%; 2.2%
Changes in tax levels			
$3–$4	0.2%	0.8273	−1.7%; 2.2%
$4–$5	0.2%	0.8302	−1.8%; 2.3%
Model specification			
Probit model	0.3%	0.7690	−1.7%; 2.3%
Current-smoker	0.6%	0.5626	−1.5%; 2.7%
Weighted with no clustering	0.2%	0.8296	−1.8%; 2.2%
Weighted with clustering	0.2%	0.8231	−1.7%; 2.1%
Heterogeneous effect by sex			
Female	−0.4%	0.6365	−2.0%; 1.2%
Male	1.1%	0.2020	−0.6%; 2.8%
Province exclusion			
Newfoundland	0.2%	0.8429	−1.8%; 2.2%
Prince Edward Island	0.2%	0.8369	−1.8%; 2.2%
Nova Scotia	−0.1%	0.9436	−2.3%; 2.2%
New Brunswick	0.2%	0.8210	−1.8%; 2.2%
Quebec	−0.5%	0.5589	−2.3%; 1.2%
Ontario	1.7%	0.0565	0.0%; 3.5%
Manitoba	0.2%	0.8496	−1.9%; 2.3%
Saskatchewan	0.1%	0.9393	−2.0%; 2.1%
Alberta	0.4%	0.7324	−2.1%; 3.0%
British Columbia	0.3%	0.7981	−1.8%; 2.4%
Included years			
2002–2004	1.7%	0.4003	−2.3%; 5.7%
2002–2005	−0.1%	0.9606	−4.0%; 3.8%
2002–2006	−0.3%	0.8935	−4.1%; 3.5%
2002–2007	−0.3%	0.8807	−3.7%; 3.2%
2002–2008	0.2%	0.9079	−2.9%; 3.3%
2002–2009	−0.3%	0.8242	−3.3%; 2.6%
2002–2010	−0.3%	0.8399	−3.0%; 2.4%
2002–2011	0.2%	0.8544	−2.2%; 2.6%

Note: Marginal effect estimates represent the incremental (additive) change in smoking prevalence for a $1.00 increase in CPI-adjusted excise cigarette taxes.

consumption. Prince Edward Island (PEI) increased cigarette taxes by the largest amount during the time of the FTCS, nominally by $3.00 per pack, and after adjustment by the CPI, by about $1.58 per pack. From 2002 to 2012, PEI experienced a decrease in smoking prevalence of about 13.4 percentage points and a decrease in mean smoking frequency of about 11.5 cigarettes. To give some perspective, Quebec had mostly flat or decreasing levels of excise cigarette tax levels during the same time frame (see Supplementary Appendix D), yet still experienced a decrease in smoking prevalence of about 17.5 percentage points and a decrease in mean smoking frequency of about 15.1 cigarettes.

The absence of an effect of tax increases on smoking may be a result of a combination of several factors. First, province fixed effects and common temporal changes accounted for much of the variation and declining trends in youth smoking. Together, they accounted for 83.7% of the variation in smoking prevalence. The inclusion of mean CPI-adjusted cigarette tax levels, however, only increased the variation explained to 83.8%. We derived similar results for smoking frequency.

A recent study evaluating the use of graphic warning labels in Canada with the United States as a control group showed a reduction in smoking prevalence by 2.8–4.7 percentage points.[15]

Table 4. Sensitivity analyses for the marginal effect of CPI-adjusted cigarette taxes on smoking frequency

Sensitivity type	Estimate	*p*-value	95% CI
Preferred model (model 3)	0.3	0.7352	–1.2; 1.8
Changes in tax levels			
$3–$4	0.3	0.7334	–1.2; 1.7
$4–$5	0.3	0.7428	–1.3; 1.9
Model specification			
Probit-Poisson TPM	0.3	0.7352	–1.2; 1.8
Logit-negative binomial TPM	0.3	0.7264	–1.3; 1.9
Weighted with no clustering	0.3	0.7694	–1.5; 2.0
Weighted with clustering	0.3	0.7585	–1.4; 1.9
Heterogeneous effect by sex			
Female	–1.3	0.1806	–3.3; 0.6
Male	2.0	0.0485	0.0; 3.9
Province exclusion			
Newfoundland	0.2	0.8203	–1.3; 1.7
Prince Edward Island	0.2	0.7805	–1.3; 1.8
Nova Scotia	0.0	0.9597	–1.7; 1.8
New Brunswick	0.2	0.7954	–1.3; 1.7
Quebec	–0.3	0.6680	–1.6; 1.0
Ontario	0.9	0.2199	–0.5; 2.3
Manitoba	0.2	0.8382	–1.4; 1.7
Saskatchewan	0.1	0.9322	–1.5; 1.6
Alberta	0.8	0.4097	–1.0; 2.6
British Columbia	0.5	0.5374	–1.1; 2.2
Included years			
2002–2004	2.1	0.2640	–1.6; 5.7
2002–2005	1.0	0.5196	–2.0; 4.0
2002–2006	0.0	0.9727	–2.6; 2.7
2002–2007	0.5	0.6693	–1.9; 3.0
2002–2008	0.4	0.7215	–1.9; 2.7
2002–2009	0.3	0.8182	–1.9; 2.5
2002–2010	–0.1	0.9429	–2.1; 1.9
2002–2011	0.1	0.8756	–1.6; 1.9

Note: Marginal effect estimates represent the incremental (additive) change in smoking frequency for a $1.00 increase in CPI-adjusted excise cigarette taxes.

This suggests that factors driving down tobacco use among youths in all provinces appear to outweigh any impact of tax increases. Thus, our null results intuitively make sense as smoking levels have decreased even within provinces with stable cigarette tax levels.

This finding leads to an important potential caveat regarding the use of tobacco taxes, namely that increases must be frequent and large enough to outweigh general price and income inflation.[4] From 2002 to 2012, each instance of an increase was often less than $1.00 per package of 20 cigarettes. When factoring in inflation, these increases were even smaller. In 2012, the *cumulative* increase in CPI-adjusted cigarette taxes since 2002 was at least $1.00 for only three provinces, Prince Edward Island, Nova Scotia and Manitoba. In this context, our results suggest that small increases in cigarette taxes, on top of already high excise tax levels and in combination with other tobacco control strategies, do not have an independent effect on youth smoking.

While there may be socio-economic inequalities in smoking, data limitations prevent an evaluation of heterogeneous effects of taxes by socio-economic factors on youth smoking. Household income was only provided in the early years of CTUMS. Moreover, an evaluation by personal income would not be appropriate as this paper focuses on youths aged 18 and under, who would generally not have independent sources of income. An evaluation by educational attainment would also not be appropriate as the majority would still be in the education system.

CONCLUSION

During the time of the Federal Tobacco Control Strategy (2002–2012), both smoking prevalence and mean smoking frequency were in steady decline among youths in Canada. Our findings suggest that changes in excise cigarette tax levels had little impact on youth smoking during this time. Our study is not suggesting that increases in excise cigarette taxes (or price) do not have the *potential* to reduce tobacco consumption, nor is it necessarily an endorsement for greater increases in cigarette taxes. It does, however, highlight the presence of declines in smoking even among provinces with stable cigarette tax levels, suggesting that other factors common to all provinces, particularly those strengthening anti-smoking sentiment, have had a greater influence over tobacco use.

REFERENCES

1. Health Canada. *Federal Tobacco Control Strategy 2001–2011: Horizontal Evaluation Final Report*. Ottawa, ON: Public Health Agency of Canada, 2012.
2. Minister of Justice. *Tobacco Act (S.C. 1997, C. 13)*, 1997. Available at: http://laws-lois.justice.gc.ca/PDF/T-11.5.pdf (Accessed February 1, 2014).
3. Chaloupka FJ, Straif K, Leon ME. Effectiveness of tax and price policies in tobacco control. *Tob Control* 2011;20(3):235–38. PMID: 21115556. doi: 10.1136/tc.2010.039982.
4. Chaloupka FJ. Maximizing the public health impact of alcohol and tobacco taxes. *Am J Prev Med* 2013;44(5):561–62. PMID: 23597823. doi: 10.1016/j.amepre.2013.02.008.
5. Reid JL, Hammond D, Burkhalter R, Rynard VL, Ahmed R. *Tobacco Use in Canada: Patterns and Trends*, 2013 ed. Waterloo, ON: Propel Centre for Population Health Impact, University of Waterloo, 2013.

6. Canadian Tax Foundation. *Finances of the Nation*. Available at: https://www.ctf.ca/CTFWEB/EN/Publications/Finances_of_the_Nation.aspx (Accessed February 1, 2014).
7. Bader P, Boisclair D, Ferrence R. Effects of tobacco taxation and pricing on smoking behavior in high risk populations: A knowledge synthesis. *Int J Environ Res Public Health* 2011;8:4118–39. PMID: 22163198. doi: 10.3390/ijerph8114118.
8. Thomas S, Fayter D, Misso K, Ogilvie D, Petticrew M, Sowden A, et al. Population tobacco control interventions and their effects on social inequalities in smoking: Systematic review. *Tob Control* 2008;17(4):230–37. PMID: 18426867. doi: 10.1136/tc.2007.023911.
9. Wilson LM, Avila Tang E, Chander G, Hutton HE, Odelola OA, Elf JL, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: A systematic review. *J Environ Public Health* 2012;2012:961724. PMID: 22719777. doi: 10.1155/2012/961724.
10. Azagba S, Sharaf M. Cigarette taxes and smoking participation: Evidence from recent tax increases in Canada. *Int J Environ Res Public Health* 2011;8:1583–600. PMID: 21655139. doi: 10.3390/ijerph8051583.
11. Nghiem N, Wilson N, Genç M, Blakely T. Understanding price elasticities to inform public health research and intervention studies: Key issues. *Am J Public Health* 2013;103(11):1954–61. PMID: 24028228. doi: 10.2105/AJPH.2013.301337.
12. Gruber J, Sen A, Stabile M. Estimating price elasticities when there is smuggling: The sensitivity of smoking to price in Canada. *J Health Econ* 2003;22(5):821–42. PMID: 12946461. doi: 10.1016/S0167-6296(03)00058-4.
13. Non-Smokers' Rights Association. *Provincial and Territorial Smoke-Free Legislation Summary*. Toronto, ON: Non-Smokers' Rights Association, 2012.
14. Canadian Cancer Society. *Cigarette Package Health Warnings: International Status Report*. Toronto, ON: Canadian Cancer Society, 2012.
15. Huang J, Chaloupka FJ, Fong GT. Cigarette graphic warning labels and smoking prevalence in Canada: A critical examination and reformulation of the FDA regulatory impact analysis. *Tob Control* 2014;23(Suppl 1):i7–12. doi: 10.1136/tobaccocontrol-2013-051170.
16. Statistics Canada. *Canadian Tobacco Use Monitoring Survey, Annual 1999 – User Guide*, 1999.
17. DeCicca P, McLeod L. Cigarette taxes and older adult smoking: Evidence from recent large tax increases. *J Health Econ* 2008;27(4):918–29. PMID: 18178277. doi: 10.1016/j.jhealeco.2007.11.005.
18. DeCicca P, Kenkel D, Mathios A. Cigarette taxes and the transition from youth to adult smoking: Smoking initiation, cessation, and participation. *J Health Econ* 2008;27:904–17. PMID: 18513811. doi: 10.1016/j.jhealeco.2008.02.008.
19. Statistics Canada. *Table 326-0020 Consumer Price Index (CPI), 2011 Basket*, 2012. Available at: http://www5.statcan.gc.ca/cansim/a26;jsessionid=6E1630FA4125B7F112FA87754CEE77C9?lang=eng&retrLang=eng&id=3260020&pattern=326-0020..326-0022&tabMode=dataTable&srchLan=-1&p1=-1&p2=31 (Accessed February 1, 2014).
20. Statistics Canada. *Table 282-0002 – Labour Force Survey Estimates (LFS), by Sex and Detailed Age Group*, 2014. Available at: http://www5.statcan.gc.ca/cansim/a05?searchTypeByValue=1&lang=eng&id=2820002&pattern=2820002 (Accessed February 1, 2014).
21. Irvine I, Nguyen HV. *Retail Tobacco Display Bans*. Toronto, ON, 2014. Available at: http://www.canadiancentreforhealtheconomics.ca/wp-content/uploads/2014/03/Hai-et-al.pdf (Accessed March 1, 2015).
22. Cragg JG. Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica* 1971;39(5):829–44. doi: 10.2307/1909582.
23. Belotti F, Deb P, Manning WG, Norton EC. twopm: Two-part models. *Stata J* 2015;15(1):3–20.
24. Korn EL, Graubard BI. Sample weights and imputation. In: *Analysis of Health Surveys*. Hoboken, NJ: John Wiley & Sons, Inc., 1999.
25. Efron B, Tibshirani R. Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. *Stat Sci* 1986;1(1):54–75.
26. Statistics Canada. *Canadian Tobacco Use Monitoring Survey, Annual 2011 – User Guide*, 2011.

Received: May 30, 2016
Accepted: February 5, 2017

RÉSUMÉ

OBJECTIFS : Évaluer l'impact des changements aux taxes sur les cigarettes sur le tabagisme des jeunes de 15 à 18 ans au Canada à l'époque de la Stratégie fédérale de lutte contre le tabagisme (SFLCT).

MÉTHODE : Nous avons utilisé un cadre de différences dans la différence en nous servant de la variation des taxes sur les cigarettes à divers endroits du Canada et au fil du temps. Nous avons utilisé des modèles de régression à effets fixes pour la province et l'année et des covariables au niveau des particuliers et au niveau provincial pour les données 2002–2012 de l'Enquête de surveillance de l'usage du tabac au Canada.

RÉSULTATS : Les augmentations de taxes n'ont généralement pas eu d'effet sur le tabagisme. Chaque hausse de 1 $ CAN (en dollars de 2000) des taxes d'accise sur les cigarettes par paquet de 20 était associée à un changement de 0,2 point de pourcentage (IC de 95 % : –1,8; 2,2) dans la prévalence du tabagisme, et à un changement de 0,3 point de pourcentage dans le nombre moyen de cigarettes fumées au cours de la semaine antérieure (IC de 95 % : –1,2; 1,8).

CONCLUSION : De 2002 à 2012, la prévalence du tabagisme et la fréquence moyenne du tabagisme étaient en baisse soutenue chez les jeunes au Canada. Cette baisse s'est toutefois manifestée même dans les provinces où les niveaux de taxation des cigarettes ont été stables ou ont diminué. Les taxes sur le tabac ont principalement augmenté depuis les années 1980; les niveaux de taxation étaient donc déjà assez élevés lors du lancement de la SFLCT. Les effets fixes pour les provinces et les changements temporels courants ont représenté 83,7 % des variations de la prévalence du tabagisme. Nous avons dérivé des résultats semblables pour la fréquence du tabagisme. L'augmentation cumulée des taxes durant la période de l'étude a été d'au moins 1 $ dans trois provinces seulement. Nos constatations portent donc à croire que les facteurs à l'origine de la baisse du tabagisme chez les jeunes dans l'ensemble des provinces l'emportent sur tout effet de légères augmentations de taxes, ces taxes étant déjà à des niveaux élevés.

MOTS CLÉS : tabac; impôts; adolescent; tabagisme; Canada