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ORIGINAL INVESTIGATION

The Effect of Graphic Cigarette Warning Labels on Smoking Behavior: Evidence from the Canadian Experience

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ABSTRACT

Introduction: There is a substantial literature that graphic tobacco warnings are effective; however, there is limited evidence based on actual smoking behavior. The objective of this paper is to assess the effect of graphic cigarette warning labels on smoking prevalence and quit attempts.

Methods: A nationally representative sample of individuals aged 15 years and older from the Canadian National Population Health Survey 1998–2008 is used. The sample consists of 4,853 individuals for the smoking prevalence regression and 1,549 smokers for quit attempts. The generalized estimating equation (GEE) model was used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. To assess the effect of graphic tobacco health warnings on smoking behavior, we used a scaled variable that takes the value of 0 for the first 6 months in 2001, then increases gradually to 1 from December 2001.

Results: We found that graphic warnings had a statistically significant effect on smoking prevalence and quit attempts. In particular, the warnings decreased the odds of being a smoker (odds ratio [*OR*] = 0.875; 95% *CI* = 0.821–0.932) and increased the odds of making a quit attempt (*OR* = 1.330, *CI* = 1.187–1.490). Similar results were obtained when we allowed for more time for the warnings to appear in retail outlets.

Conclusion: This study adds to the growing body of evidence on the effectiveness of graphic warnings. Our findings suggest that warnings had a significant effect on smoking prevalence and quit attempts in Canada.

INTRODUCTION

The adverse health effects of tobacco use are well established (Centers for Disease Control and Prevention, 2008). Globally, annual smoking-attributable deaths are estimated to be 6 million, with 600,000 nonsmokers exposed to environmental tobacco smoke (World Health Organization [WHO], 2011). In Canada, smoking is the leading cause of premature and preventable mortality. It is responsible for more than 45,000 deaths and a total economic burden of $15 billion per year (Health Canada, 2002). To address the rising smoking epidemic, the WHO Framework Convention on Tobacco Control (FCTC) requires member countries to implement measures aimed at reducing the demand for tobacco products (WHO, 2008). Article 11 of the FCTC provides guidelines for warning messages on cigarette packages. It recommends the use of rotating, large, clear, and visible graphic warning messages and it should cover 50% or more of the principal display areas of the package (WHO, 2008). In line with the global effort to curb the rising smoking epidemic, the Government of Canada implemented several measures to discourage smoking. In January 2001, Canada became the first country in the world to enforce graphic health warning labels on cigarette packages. The warnings occupied 50% of the principal display area and appeared in English and French on both sides of the package.

Externalities in the form of nonsmokers' exposure to tobacco smoke, lack of self-control, and imperfect knowledge of the health risks of tobacco use are widely used to justify the need for intervention measures (Chaloupka & Warner, 2000). Most smokers are unaware of the health risks of tobacco use (WH[WHO], 2011), and graphic warnings have been documented as a useful channel for informing individuals about the health hazards of smoking. A one-pack-per-day smoker is exposed to graphic warnings up to 20 times a day (Hammond, 2011).

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Several studies have assessed the effectiveness of graphic warnings in discouraging smoking (For a recent review of the literature, see Hammond, 2011). Evidence from population-based surveys, together with empirical research, showed that graphic warnings—particularly large, prominent, and comprehensive warnings—are effective in discouraging smoking initiation (European Commission, 2009; Vardavas et al., 2009) and encouraging smoking cessation (Hammond et al., 2003; Miller et al., 2009). A number of Canadian studies found that pictorial cigarette health warnings are effective (e.g., Hammond et al., 2003, 2004; Health Canada, 2001). Empirical evidence from other countries (e.g., Health Promotion Board, 2004; Li & Grigg, 2009; Miller et al., 2009; Nascimento et al., 2008; Vardavas et al., 2009; Webster & Wakefield, 2008) and cross-country studies (e.g., Borland et al., 2009; Givel, 2007; Hammond et al., 2006, 2007) have shown that graphic health warnings are effective. For example, in Australia, Miller et al. (2009) noted that the call volume to the help quitline increased following the introduction of warning messages on cigarette packs. In Singapore, 47% of smokers reported decreased cigarette consumption after pictorial warning labels were introduced (Health Promotion Board, 2004)

Research has shown that graphic warnings were more effective than text-only messages. Graphic warnings induced a greater emotional response, were more likely to retain their salience over time, and increased awareness of health risks, compared with text warnings (Hammond et al., 2006; Hammond, 2011). Similarly, cross-country studies found that large and graphic health warning images were more effective in stimulating cognitive reactions (i.e., quit intentions as a result of increased knowledge of the health risks of smoking) compared with text-only warnings (Borland et al., 2009; Hammond et al., 2006, 2007). Givel (2007) compared Canadian cigarette pictorial warning labels to the U.S. text-only messages and found Canadian pictorial labels to be more effective in promoting smoking cessation. There is also evidence that graphic warnings supplement other tobacco-control measures to discourage smoking. For example, Chang et al. (2011) found that the implementation of Taiwan's graphic cigarette warning labels, in combination with smoke-free laws, were effective in increasing awareness of the harmful effects of smoking and thoughts of cessation. Similarly, Brennan et al. (2011) found evidence of complementary effects between graphic warnings and television advertisement in increasing the knowledge of the health risks of smoking and motivating smoking cessation in Australia.

There is substantial literature that graphic tobacco warnings are effective; however, there is limited evidence based on actual smoking behavior. Previous studies have relied on respondents' answers to questions about the graphic health warnings to determine their effectiveness. Some of the measures of effectiveness include desire to quit, increased health knowledge of tobacco risks, ability to recall the messages, and self-reported effectiveness. Although these measures may predict future behavior, subjects tend to provide logical responses to questions that involve an appeal to fear. These answers may not reflect actual behavior and hence may not provide an objective assessment of the effect of graphic warnings (Hastings et al., 2004; Ruiter & Kok, 2005). Accordingly, this study takes a different approach by using survey data that have smoking-related information without any health warning questions. The objective of this paper is to assess the effect of graphic cigarette warning labels on actual smoking behavior. We used longitudinal data from the Canadian National Population Health Survey (NPHS, 1998–2008), which covers both pre- and postpolicy periods.

Brief Institutional Background

The Canadian health warning labels started with four rotating text messages, covering 20% of the front and back of the package, in English and French, under the federal law of 1989. Subsequently, there has been an increase in the number of messages. In 1994, a new set of eight rotating black-and-white text-warning messages, occupying 35% of the front and back of the package were implemented (Cismaru & Lavack, 2007; Non-Smokers' Rights Association, 2003). In 1995, the Supreme Court of Canada removed the legal basis for imposing these warnings. It was not until 1997 when the parliament passed the Tobacco Act that the government got the right to regulate the packaging of cigarettes. The Tobacco Act of 1997 enforced a set of regulations concerning advertising and packaging of tobacco products. In June 2000, the Tobacco Products Information Regulations (TPIR) under the Tobacco Act became a law, and tobacco companies were given a grace period until the end of December 2000 to add the new warning labels. The new regulation mandated the display of one of 16 different-colored graphic warnings on at least 50% of the principal display area. It appears in English and French on both sides of the package. The regulation also mandated the inclusion of messages inside the package about the health risks of smoking and messages to help smokers quit (Health Canada, 2000). Since then, the warning message labelling on tobacco products became an integral component of a comprehensive tobacco-control strategy to discourage smoking. Parallel to the introduction of the Canadian graphic warnings, there has been a substantial increase in cigarette taxes both at the federal and provincial levels, which resulted in higher cigarette prices. In April 2001, the Federal Tobacco Control Strategy proposed raising tobacco taxes, in addition to other measures, to reduce smoking and exposure to secondhand smoke (Health Canada, 2002). This triggered a sequence of tax hikes. At the federal level, the excise tax was first raised to $10.99 per carton in May 2001, and then to $12.62 by the end of 2001. In mid-2002, the federal tax was further raised to $13.86 per carton and then to $15.85 in July 2002 (Gabler and Katz, 2010).

Canadian provinces followed the federal government and increased their taxes on cigarettes, but by different magnitudes. For example, between 2000 and 2003, real cigarette taxes almost doubled in Ontario, Alberta, New Brunswick, and Nova Scotia. Taxes increased by 83% in Québec, 70% in Manitoba and Saskatchewan, 45% in British Colombia, and 37% in Newfoundland. After 2003, nominal taxes were subject to small increases to offset the impact of inflation.

In line with the Federal Tobacco Act, Canadian provinces implemented legislations to ban smoking in public places and workplaces (Health Canada, 2007). In January 1, 2005, the Saskatchewan Tobacco Control Act banned smoking in all enclosed public places, including restaurants, bars, and casinos. This was followed by the Newfoundland and Labrador Smoke-free Environmental Act in July 1, 2005. In January 1, 2006, Alberta enforced its Smoke-free Places Act. The Smoke-free Ontario Act and Quebec's Tobacco Act become effective on May 31, 2006. Nova Scotia enforced its Smoke-free Places Act on December 1, 2006. In April 2008, British Columbia implemented a ban on smoking in public places throughout the province (Shields, 2007).

Though the Tobacco Act of 1997 called for banning tobacco advertising, it continued to allow point-of-sale display of tobacco products, as well as sponsorship promotion by tobacco companies. As of October 1, 2003, tobacco companies were prohibited from using the sponsorship of cultural and sports events as an avenue to advertise their tobacco products. Tobacco companies tried to get around these restrictions by using retail stores as a channel to promote tobacco products (Cohen et al., 2008). To address this challenge, the point-of-sale displays of tobacco products were the target of provincial policies. Saskatchewan was the first province to adopt a display restriction in 2002, but the policy was struck down after a challenge from tobacco companies. Since then, all Canadian provinces have implemented a display ban, beginning with Manitoba (2004), followed by Saskatchewan (2005), Prince Edward Island (2006), Nova Scotia (2007), British Columbia, Ontario, Quebec and Alberta (2008), New Brunswick (2009), and Newfoundland and Labrador (2010) (The Ontario Tobacco Research Unit, 2010).

METHODS

Data

This study used nationally representative data from the Canadian NPHS. A detailed description of the NPHS has been documented elsewhere (Statistics Canada, 2009). Briefly, the NPHS is a longitudinal dataset that contains information on each respondent's health-related characteristics, as well as corresponding economic and sociodemographic variables. The first cycle of the NPHS was conducted in 1994/1995 and, since then, respondents have been reinterviewed every 2 years. We used balanced panel data from Cycle 3 (1998/1999) to Cycle 8 (2008/2009) and the sample was restricted to the adult population aged 15 years and older. The sample consisted of 4,853 individuals, resulting in 29,118 person–year observations for smoking prevalence, whereas for quit attempts, there were 1,549 smokers and 6,269 person–year observations.

Measures

Outcome Variables: Smoking Behavior

We used two self-reported measures of smoking behavior: smoking prevalence and quit attempts. Smoking prevalence is derived from participants' responses to the survey question, "At the present time do you smoke cigarettes daily, occasionally or not at all?" We have created a dichotomous indicator for smoking status, which takes the value of one if an individual reports smoking cigarettes daily or occasionally; and zero otherwise. If daily and occasional smokers reported trying to quit smoking in the past 6 months, they were assigned the value one, indicating a quit attempt; otherwise a zero was recorded.

We did not examine the intensity of smoking. This is normally measured by the number of cigarettes consumed. Recent evidence suggested that the quantity smoked does not necessarily reflect the actual intensity of smoking (Adda & Cornaglia, 2006; Farrelly et al., 2004). Smokers may reduce the quantity of cigarettes smoked but increase the intensity with which they smoke each cigarette. Moreover, in response to higher cigarette prices, Farrelly et al. (2004) found that some smokers increase tar and nicotine intake in order to compensate for a reduction in the quantity of cigarettes smoked. Unfortunately, the level of nicotine intake is not available in the NPHS.

Graphic Warnings Variable

To assess the effect of graphic tobacco health warnings on smoking behavior, we created a policy variable to capture pre- and postpolicy periods using three approaches. First, we used a dichotomous indicator that takes the value of one from July 2001 onward and zero otherwise. July 2001 is used as the starting point to capture the period when graphic warnings were prevalent in retail shops. In the second approach, we allowed more time for the policy to take effect by creating a dummy variable that takes the value of one from December 2001 onward and zero otherwise. Third, we used a scaled variable that takes the value of zero for the first 6 months in 2001, then increases gradually to one from December 2001 (the following scale was used: 0.1 for July 2001; 0.3 for August; 0.5 for September; 0.7 for October, and 0.9 for November).

Control Variables

We included the following standard covariates in the analyses: gender; age groups: 15–24 (reference group = ref), 25–34, 45–64, and 65 or older; educational attainment: less than secondary (ref), secondary, some postsecondary, and postsecondary; household income in quartiles adjusted for the household size: low income (ref), low-middle income, high-middle income, and high income; marital status: single (ref), separated or widowed, and married; household size; employment status: employed (ref) and unemployed; immigration status: nonimmigrant (ref) and immigrant; workplace smoking bans: no ban (ref), partial ban, and full ban; and province of residence. The analyses also controlled for cigarette prices. We constructed a yearly average of cigarette prices from 1998 to 2009 using the monthly cigarette price index for each province from the Canadian Socioeconomic Information Management System (CANSIM) and the provincial nominal cigarette prices, as of March 31, 2006, from the Non-Smokers' Rights Association (Non-Smokers' Rights Association, 2006). To obtain the inflation-adjusted cigarette price, the province-specific consumer price index obtained from CANSIM was used to deflate the nominal cigarette prices.

Following Fagan et al. (2007), Kahende et al. (2011), and Herrick (2000), we used a standard set of variables, including a proxy for nicotine dependence, in the quit attempt analysis. For our measure of nicotine dependence among smokers, we used the time to the first cigarette after waking and the average number of cigarettes smoked per day. Previous studies using structural equation modeling have shown both these as good measures for nicotine dependence (Nonnemaker & Homsi, 2007; Richardson & Ratner, 2005). We used three categories for quantity smoked: less than 11 (ref); 11 to 19; and 20 or more cigarettes/day. The time to first cigarette after waking was categorized as follows: within 30 min (ref); 31–60 min; and more than 60 min.

Statistical Analysis

A generalized estimating equation (GEE) model was used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. We used the GEE framework because the population-averaged response for graphic warnings "is directly estimable from

Table 1. Selected Characteristics of the Respondents Included in the Study Analyses

	Percentage (*SD*)			
	Smoking prevalence		Quit attempts	
Gender				
Male	50.5	(0.500)	50.9	(0.500)
Female	49.5	(0.500)	49.1	(0.500)
Age				
Age 15–24	7.1	(0.257)	10.2	(0.302)
Age 25–34	17.7	(0.381)	23.1	(0.422)
Age 35–44	24.8	(0.432)	28	(0.449)
Age 45–64	38.7	(0.487)	33.4	(0.472)
Age 65+	11.7	(0.321)	5.3	(0.224)
Education level				
Less than secondary	12.6	(0.332)	13.6	(0.342)
Secondary	14.3	(0.350)	17.8	(0.383)
Some postsecondary	27.4	(0.446)	29.3	(0.455)
Postsecondary	45.7	(0.498)	39.2	(0.488)
Income level				
Low income	6.1	(0.240)	10.4	(0.305)
Low-middle income	15.7	(0.364)	16.8	(0.374)
High-middle income	35.9	(0.480)	37.6	(0.484)
High income	42.3	(0.494)	35.3	(0.478)
Marital status				
Married	67.4	(0.469)	56.7	(0.495)
Separated	13.8	(0.345)	18.2	(0.386)
Single	18.9	(0.391)	25.1	(0.433)
Employment status				
Employed	74.3	(0.437)	79.4	(0.404)
Unemployed	25.7	(0.437)	20.6	(0.404)
Immigration status				
Immigrant	16.6	(0.372)	11.1	(0.314)
Nonimmigrant	83.4	(0.372)	88.9	(0.314)
Smoking bans				
Full ban	47.0	(0.500)	36.2	(0.481)
Partial ban	20.0	(0.400)	27.1	(0.445)
No ban	32.6	(0.468)	36.6	(0.482)
Province of residence				
Newfoundland	1.8	(0.134)	1.8	(0.134)
Prince Edward	0.6	(0.074)	0.9	(0.095)
Nova Scotia	3.4	(0.182)	3.7	(0.189)
New Brunswick	2.6	(0.158)	2.5	(0.155)
Quebec	24.8	(0.432)	25.6	(0.437)
Ontario	40.2	(0.490)	39	(0.488)
Manitoba	3.3	(0.178)	3.5	(0.184)
Saskatchewan	2.8	(0.164)	3.5	(0.184)
Alberta	9.8	(0.298)	11	(0.312)
British Columbia	10.8	(0.310)	8.5	(0.279)

observations without assumptions about the heterogeneity across individuals in the parameters" (Zeger et al., 1988). Separate analyses were performed using the three measures of graphic warnings. To determine whether graphic health warnings, as a dichotomous variable, and cigarette prices in levels can be identified separately in the regression, we used a rule of thumb by estimating a variance inflation factor (VIF). A VIF of 7.64 is obtained when a graphic dummy is regressed on cigarette prices. The VIF thus confirms that there is sufficient independent price variation in the sample to identify the price effect in the analyses.

To check whether the analyses are sensitive to the inclusion of additional control variables, two model specifications are used. Model 1, the baseline specification, controlled for gender, age, educational attainment, income level, marital status, household size, employment status, and immigration status. In addition to the baseline covariates in Model 1, Model 2 included workplace smoking bans and provincial fixed effects. In Model 3, we reestimated Model 2 but restricted the sample to daily smokers. The multivariate analysis is conducted using Stata 11.

RESULTS

Table 1 presents the characteristics of the respondents included in the study. Among the study sample, about half are male, a

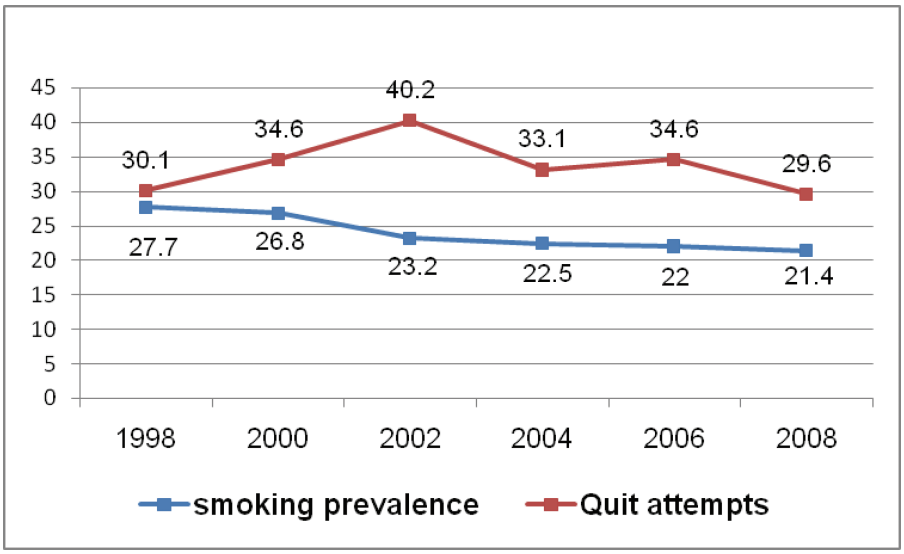

Figure 1. Smoking prevalence and quit attempts. *Source*: Authors' compilation using data from NPHS.

large percentage is 35 years and older, less than 20% are immigrants. A significant proportion of the sample is well educated, with most (more than 70%) having completed some post-secondary education. The trend of both smoking prevalence and smokers' quit attempts from 1998 to 2008 are shown in Figure 1. For smoking prevalence, there has been a gradual decrease in the smoking participation rate. The percentage of smokers reporting past quit attempts increased between 1998 and 2002, with a significant drop in 2004 and 2008. Although there has been a decline in smoking prevalence in Canada, the largest decrease in smoking prevalence—and the largest increase in quit attempts—for our study period occurred between 2000 and 2002 (see Figure 1). We cannot determine from the unconditional analysis whether the graphic warnings had any significant impact on smoking behavior during this period because there was also a major increase in cigarette taxes and prices. Tables 2 and 3 report the odds ratios (*OR*) and the corresponding 95% *CI* from the GEE regression for the smoking prevalence and quit attempts, respectively. The estimates from the GEE model are interpreted as population-average (marginal) effects rather than subject-specific effects.

Smoking Prevalence

The tobacco graphic cigarette warnings, represented by the scaled variable, had a statistically significant effect on smoking prevalence (see Table 2). The policy variable decreased the odds of being a smoker (*OR* = 0.875, *CI* = 0.821–0.932; Model 2). The graphic warnings also decreased the odds of being a daily smoker (*OR* = 0.868, *CI* = 0.809–0.931; Model 3). Though not reported in the manuscript (but available as a supplementary file), the results were similar when the policy dummy is defined to be one from July 2001, and zero otherwise ([*OR* = 0.874, *CI* = 0.820–0.931; Model 2] and [*OR* = 0.864, *CI* = 0.805–0.927; Model 3]). The results from the warnings variable, defined to be one from December 2001, indicated that warnings decreased the odds of being a smoker (*OR* = 0.875, *CI* = 0.821–0.932; Model 2) and the odds of being a daily smoker (*OR* = 0.869, *CI* = 0.810–0.931; Model 3).

In terms of the other control variables (Table 2), those older and with a higher education (except secondary) were less likely to be smokers compared with their respective reference categories. Males were more likely to be smokers than females (*OR* = 1.156, *CI* = 1.025–1.304). The income variable shows the standard socioeconomic gradient in smoking, where those with higher income status are less likely to be smokers. The odds of being a smoker were found to be lower for those who were married (*OR* = 0.842, *CI* = 0.759–0.934), immigrants (*OR* = 0.579, *CI* = 0.458–0.732), and had higher household size (*OR* = 0.984, *CI* = 0.962–1.001). Those separated or widowed (*OR* = 1.066, *CI* = 0.934–1.217) were more likely to be smokers than those who were single, and those employed (*OR* = 1.173, *CI* = 1.084–1.269) had higher odds of being smokers than those unemployed. Lower odds of smoking were associated with cigarette price (*OR* = 0.790, *CI* = 0.663–0.942) and full ban on workplace smoking (*OR* = 0.916, *CI* = 0.857–0.979).

Quit Attempts

The reported results in Table 3 indicate that graphic warnings, using a scale variable representation, had a positive and statistically significant effect on quit attempts among smokers. Graphic warnings increased the odds of making a quit attempt (*OR* = 1.330, *CI* = 1.187–1.490; Model 2). Among daily smokers, graphic warnings also increased the odds of making a quit attempt (*OR* = 1.331, *CI* = 1.175–1.508; Model 3). A similar result was obtained (available in the supplementary file) when the policy dummy is defined to be one from July 2001 and zero otherwise (*OR* = 1.329, *CI* = 1.188–1.490; Model 2). Using the warnings variable defined to be one from December 2001 indicated that warnings increased the odds of making a quit attempt among daily smokers (*OR* = 1.332, *CI* = 1.176–1.508; Model 3).

Results for the other covariates revealed no statistically significant relationship between gender, income status, marital status, household size, immigration, and workplace smoking ban and the odds of attempting to quit. Older adults and those employed were less likely to make a quit attempt. Immigrants and the well educated were more likely to have attempted

Table 2. Odds Ratios (95% *CI*) for the Smoking Prevalence Regression

	Model 1	Model 2	Model 3
Graphic warnings	0.874***	0.875***	0.868***
	(0.821–0.930)	(0.821–0.932)	(0.809–0.931)
Male	1.167**	1.156**	1.153**
	(1.035–1.315)	(1.025–1.304)	(1.014–1.311)
Age 25–34	0.989	0.990	1.102
	(0.876–1.116)	(0.876–1.117)	(0.958–1.268)
Age 35–44	0.901	0.904	1.011
	(0.783–1.038)	(0.786–1.041)	(0.860–1.188)
Age 45–64	0.763***	0.766***	0.896
	(0.655–0.888)	(0.657–0.892)	(0.753–1.066)
Age 65+	0.588***	0.587***	0.629***
	(0.494–0.698)	(0.493–0.698)	(0.516–0.767)
Secondary	1.003	1.009	0.949
	(0.827–1.217)	(0.832–1.222)	(0.781–1.155)
Some postsecondary	0.861*	0.863*	0.837**
	(0.736–1.009)	(0.737–1.010)	(0.717–0.976)
Postsecondary	0.837**	0.840**	0.730***
	(0.715–0.979)	(0.719–0.983)	(0.622–0.856)
Low-middle income	0.938	0.936	0.926*
	(0.866–1.015)	(0.865–1.014)	(0.846–1.014)
High-middle income	0.888***	0.888***	0.865***
	(0.812–0.971)	(0.812–0.971)	(0.783–0.955)
High income	0.868***	0.868***	0.834***
	(0.787–0.957)	(0.787–0.957)	(0.751–0.926)
Married	0.842***	0.842***	0.842***
	(0.759–0.933)	(0.759–0.934)	(0.749–0.947)
Separated	1.061	1.066	1.030
	(0.929–1.211)	(0.934–1.217)	(0.890–1.192)
Household size	0.984	0.984	0.981
	(0.962–1.007)	(0.962–1.008)	(0.955–1.007)
Employed	1.121***	1.173***	1.116**
	(1.055–1.191)	(1.084–1.269)	(1.023–1.218)
Immigrant	0.567***	0.579***	0.546***
	(0.451–0.714)	(0.458–0.732)	(0.421–0.707)
Cigarette price	0.787***	0.790***	0.714***
	(0.662–0.936)	(0.663–0.942)	(0.587–0.868)
Full ban		0.916***	0.933*
		(0.857–0.979)	(0.868–1.002)
Partial ban		0.988	1.030
		(0.918–1.062)	(0.952–1.114)
Newfoundland		0.963	0.892
		(0.720–1.288)	(0.656–1.211)
Prince Edward Island		1.201	1.237
		(0.891–1.619)	(0.903–1.694)
Nova Scotia		1.127	1.171
		(0.852–1.491)	(0.887–1.546)
New Brunswick		1.044	1.199
		(0.788–1.382)	(0.910–1.580)
Quebec		1.083	1.133
		(0.857–1.368)	(0.894–1.435)
Ontario		1.050	1.055
		(0.842–1.309)	(0.861–1.292)
Manitoba		0.985	1.048
		(0.755–1.285)	(0.803–1.367)
Saskatchewan		1.209	1.265*
		(0.939–1.556)	(0.986–1.623)
Alberta		1.249*	1.308**
		(0.974–1.601)	(1.053–1.625)

Note. ***$p < .01$, **$p < .05$, *$p < .1$.

Table 3. Odds Ratios (95% *CI*) for the Quit Attempts Regression

	Model 1	Model 2	Model 3
Graphic warnings	1.326***	1.330***	1.331***
	(1.184–1.485)	(1.187–1.490)	(1.175–1.508)
Male	1.009	1.008	0.961
	(0.865–1.176)	(0.863–1.176)	(0.808–1.143)
Age 25–34	0.624***	0.626***	0.572***
	(0.482–0.809)	(0.482–0.813)	(0.431–0.760)
Age 35–44	0.554***	0.559***	0.541***
	(0.421–0.730)	(0.423–0.738)	(0.400–0.730)
Age 45–64	0.489***	0.491***	0.491***
	(0.366–0.654)	(0.366–0.660)	(0.357–0.676)
Age 65+	0.427***	0.418***	0.398***
	(0.287–0.634)	(0.282–0.621)	(0.257–0.617)
Secondary	1.136	1.138	1.120
	(0.877–1.472)	(0.876–1.478)	(0.846–1.483)
Some postsecondary	1.161	1.157	1.164
	(0.925–1.459)	(0.920–1.455)	(0.912–1.485)
Postsecondary	1.104	1.098	1.194
	(0.880–1.387)	(0.873–1.383)	(0.935–1.524)
Low-middle income	1.042	1.048	1.047
	(0.848–1.279)	(0.853–1.288)	(0.843–1.300)
High-middle income	1.003	1.021	0.985
	(0.812–1.239)	(0.825–1.263)	(0.787–1.234)
High income	0.876	0.890	0.824
	(0.692–1.108)	(0.701–1.132)	(0.635–1.068)
Married	0.987	0.963	0.883
	(0.810–1.203)	(0.789–1.174)	(0.710–1.096)
Separated	1.042	1.022	0.922
	(0.828–1.312)	(0.811–1.288)	(0.720–1.181)
Household size	1.010	1.012	1.031
	(0.955–1.068)	(0.957–1.070)	(0.969–1.098)
Employed	0.756***	0.801**	0.824*
	(0.653–0.876)	(0.653–0.984)	(0.660–1.029)
Immigrant	1.044	1.064	1.030
	(0.792–1.377)	(0.805–1.407)	(0.748–1.418)
Smoked 11–19 cigarettes/day	0.693***	0.690***	0.726***
	(0.600–0.801)	(0.597–0.798)	(0.617–0.855)
Smoked >20 cigarettes/day	0.561***	0.561***	0.615***
	(0.479–0.658)	(0.478–0.658)	(0.510–0.741)
Smoke within 31–60 min after waking			1.166*
			(0.992–1.372)
Smoke after 60 min from waking			1.050
			(0.876–1.259)
Full ban		0.931	0.943
		(0.767–1.129)	(0.762–1.167)
Partial ban		0.916	0.898
		(0.753–1.114)	(0.725–1.113)
Newfoundland		1.134	0.955
		(0.765–1.682)	(0.612–1.490)
Prince Edward Island		1.044	0.964
		(0.704–1.546)	(0.616–1.509)
Nova Scotia		1.187	1.067
		(0.817–1.722)	(0.705–1.613)
New Brunswick		0.894	0.916
		(0.590–1.355)	(0.584–1.437)
Quebec		1.003	1.024
		(0.730–1.377)	(0.716–1.464)
Ontario		1.024	1.015
		(0.755–1.390)	(0.714–1.444)
Manitoba		1.089	0.947
		(0.736–1.612)	(0.614–1.461)
Saskatchewan		1.602**	1.440
		(1.074–2.388)	(0.916–2.265)
Alberta		1.119	1.016
		(0.802–1.561)	(0.690–1.496)

Note. ***$p < .01$, **$p < .05$, *$p < .1$.

quitting smoking. The measure for nicotine dependence showed a statistically significant effect on quit attempt. Decreased odds of making a quit attempt were associated with consuming 20 or more cigarettes/day (*OR* = 0.561, *CI* = 0.478–0.658; Model 2) and between 11 and 19 cigarettes/day (*OR* = 0.690, *CI* = 0.597–0.798) compared with those consuming less than 11 cigarettes/day. Among daily smokers (reported in Table 2, Model 3), increased odds of making a quit attempt were associated with having the first cigarette after waking between 31 and 60 min (*OR* = 1.166, *CI* = 0.991–1.371) and more than 60 min (*OR* = 1.050, *CI* = 0.876–1.259).

DISCUSSION

In January 2001, Canada became the first county in the world to introduce pictorial warning messages on cigarette packs. As of June 2011, more than 40 countries have implemented similar warning messages (Tobacco Free Center, 2011). Since then, a growing body of research has been conducted to assess the effectiveness of this policy in discouraging smoking. Previous studies mostly agree that graphic cigarette warnings appear effective; however, there is limited evidence based on actual smoking behavior. This study adds to the existing literature by using longitudinal data from the Canadian NPHS (1998–2008), which covers pre- and postpolicy periods to assess the effect of graphic warning labels on actual smoking behavior. The multivariate analysis showed that graphic warnings has a statistically significant association with lower smoking prevalence and increased quit attempts.

The positive effect of the graphic warning on quit attempts is in line with the findings of several previous studies (e.g., Borland et al., 2009; Hammond et al., 2003). For example, in a Canadian study, Hammond et al. (2003) found that smokers who noticed, thought about, and discussed the new graphic labels at baseline were more likely to quit or to make a quit attempt. Borland et al. (2009) found that forgoing cigarettes and cognitive reactions as a result of warnings consistently predicts quit attempts. Though not directly comparable, our results are consistent with projection-based studies that have assessed the potential effect of warning labels on smoking prevalence within the context of a tobacco-control-simulation framework, "SimSmoke" (e.g., Levy et al., 2008; Nagelhout et al., 2011). The findings of an early study by Gospodinov & Irvine (2004) runs contrary to our results. The authors used cross-sectional data collected 6 months before the graphic warnings policy was introduced and 5 months after introduction to evaluate the immediate effect of the policy on smoking behavior. They found that pictorial warnings had no significant impact on smoking prevalence. However, in this current study, we used a longer time period and longitudinal data. Also, the warnings variable was captured in ways that allow the messages to diffuse throughout the retail shops.

Some potential limitations of this study warrant discussion. First, the outcome measures, smoking participation, and quit attempts are self-reported. However, this is standard in the literature, and the longitudinal structure of the NPHS may help to mitigate any measurement error bias so long as the errors are random. Second, due to data limitations, there may be other relevant confounding factors that we did not control for. For example, there is no information in the survey about participation in the black market or about the type of cigarettes (discount or premium) smokers consumed. Also, there is no information about compensatory behaviors. As a result, our estimates of the effect of graphic warnings on smoking prevalence and quit attempts may be biased. The smuggling of cigarettes and the existence of a considerable black market (estimated to satisfy about 30% of the demand in Canada) may partially offset the effects of the graphic warnings on smoking behavior (Gabler & Katz, 2010). For example, cigarette packs smuggled from the United States into Canada do not currently contain graphic warnings. Nonetheless, the inclusion of provincial dummies may help capture some of the smuggling effect in Canadian border provinces. The scope of the contraband cigarette market in Canada has been steadily expanding. According to estimates by Physicians for a Smoke-Free Canada (2010), contraband cigarette sales as a percentage of the total cigarette sales has increased from 7% (2002) to 10% (2003), 20% (2006), 27% (2007), and 31% (2008).

Graphic warnings may also be prone to wear out (Hammond et al., 2007). In response to the wear-out effect, in September 2011, Canada introduced new tobacco graphic warning regulations, which will increase the size of the graphic warnings to 75% along with other modifications. The new regulations allow for a transition period of up to 6 months for industry to introduce the new labels on packages, and an additional 3 months for retailers to clear up their inventory with the old warning labels (Health Canada, 2011). Despite these limitations, we believe that this study is timely and relevant for policy makers to understand the Canadian experience, especially for countries that are in the process of implementing graphic cigarette warnings. For example, from September 2012, the United States will implement graphic warning labels on cigarette packs.

In summary, existing evidence on the effectiveness of graphic warnings were mainly based on emotional responses and projections from simulation models. The current study is among the first to provide longitudinal evidence at the population level that graphic tobacco warnings had a statistically significant impact on smoking prevalence. Given the differences in the antismoking policy environment across countries, further empirical evidence from other countries will be needed before reaching a generalized conclusion.

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DECLARATION OF INTERESTS

None declared.

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