



Changes in smokers' responses to novel efficacy messages inside cigarette packages following Canada's 2024 labeling policy update: A pre-post longitudinal study

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ABSTRACT

Objective: Evaluate the impact of Canada's innovative inside-pack efficacy messages about cessation benefits and tips to quit, whose content was updated in 2024.

Methods: We analyzed data from an open cohort of Canadian adults who smoke, surveyed every three months from February 2023 to November 2024 ($n = 12,022$ observations, 4716 individuals). At each survey, participants reported the frequency of reading health messages inside packs in the past 30 days (Never/Rarely = reference vs Sometimes/Often/Very often); perceived cessation benefits from inside-pack messages (Not at all-Extremely); forgoing cigarettes due to inside-pack messages in the prior 30 days (No = reference vs Yes); and confidence/self-efficacy to quit smoking (Not at all-Extremely). Linear and logistic generalized estimating equation models regressed these outcomes on implementation period (pre- vs post-implementation surveys). Analyzing participants followed to the subsequent survey ($n = 6959$ observations, 2356 individuals), mixed-effects logistic models regressed quit attempts in the three-month interval since the prior survey on message responses from the prior survey. All models adjusted for sociodemographics, smoking-related variables, and post-stratification weights.

Results: Self-reported reading inside-pack messages (OR = 1.18; 95 %CI = 1.04, 1.34), perceived cessation benefits ($\beta = 0.07$; 95 %CI = 0.01, 0.12), forgoing cigarettes (OR = 1.14; 95 %CI = 1.01, 1.28), and self-efficacy ($\beta = 0.08$; 95 %CI = 0.04, 0.13) all increased from pre- to post-implementation. Participants who reported reading messages more frequently (OR = 1.54; 95 %CI = 1.09–2.00), perceived greater cessation benefits (OR = 1.31; 95 %CI = 1.22, 1.42), forwent cigarettes (OR = 1.88; 95 %CI = 1.48, 2.37) and had greater self-efficacy (OR = 1.32; 95 %CI = 1.19, 1.47) were more likely to quit at followup.

Conclusions: After Canada implemented new efficacy messages inside packs, message engagement and predictors of cessation behaviors increased. Other countries may consider similar policies.

1. Introduction

Pictorial health warning labels (PHWLs) printed on the outside of cigarette packages are a key policy of the World Health Organization's Framework Convention on Tobacco Control and have now been adopted

by over 120 countries (Canadian Cancer Society, 2023). Canada's labeling policy goes beyond this by also including health messages inside of cigarette packs that describe the benefits of quitting, offer cessation tips, and include information about cessation resources (Centre TLR, n.d.). Some evidence from brief randomized trials in the US (Lambert

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et al., 2018; Thrasher et al., 2024; Lambert et al., 2024) and post-policy implementation research in Canada (Thrasher et al., 2015; Thrasher et al., 2016a) suggests such inside-pack messages can enhance efficacy beliefs and encourage quit-related behaviors and quit attempts. The current study extends this research by evaluating responses to these messages among Canadian adults who smoke before and after implementation of new message content.

Countries that have implemented PHWLs invariably use graphic imagery to show the harmful health effects of smoking. Such messages elicit negative emotions, like fear, which can raise risk awareness, prompt warning discussions, and increase quit motivation and behaviors compared to text-only warnings (Brewer et al., 2019; Yong et al., 2014; Boynton et al., 2016; Noar et al., 2016; Cho et al., 2018). Behavior change theories, such as the Extended Parallel Process Model and Protection Motivation Theory, posit that such fear appeals are most effective when paired with messages that also promote perceptions of the benefits of engaging in the recommended behavior (i.e., response efficacy) and confidence or self-efficacy to do it (Witte, 1994; Prentice-Dunn and Rogers, 1986; Popova, 2012). Although fear-based messages alone can prompt desired behaviors, adding efficacy information can enhance their impact by generating reinforcing confidence in protective actions and their benefits (Nabi and Myrick, 2019; Tannenbaum et al., 2015; Bigsby and Albarracín, 2022).

Evidence is growing around the potential benefits of including inside-pack efficacy messages to complement fear-arousing PHWLs on cigarette packages. One observational study conducted over the two years after new labeling content was implemented in Canada found that adults who smoke and more often engaged with inside-pack messages increased their self-efficacy to quit smoking and were more likely to both attempt to quit and to maintain more than 30 days of abstinence compared to those who did not read these messages (Thrasher et al., 2016a). Moreover, adults who smoke report that these types of messages motivate them and would help them to quit smoking (Thrasher et al., 2018; Loud et al., 2021; Moodie, 2018). Similarly, in a two-week cross-over study, US adults who smoke had greater self-efficacy to quit, higher response efficacy, and greater quit motivation during the week when their packs contained inside-pack messages (Lambert et al., 2018). Another two-week randomized controlled trial (RCT) among US adults who smoke found that exposure to packs with efficacy messages led participants to think about cessation benefits more frequently and have a higher likelihood of forgoing cigarettes (Thrasher et al., 2024; Lambert et al., 2024) – a consistent predictor of subsequent cessation attempts (Partos et al., 2014; Borland et al., 2009a).

Since 2000, Canada has pioneered cigarette labeling policies, including updates in 2012 and 2024 to both external warnings and internal efficacy messages. The 2020 plain packaging regulation standardized packs to “slider” formats (See Supplemental Fig. 1), where an extended upper flap directed consumers to efficacy messages printed on the back of the inner cigarette sheath. In June 2023, Canada announced new regulations to update the 2012 cigarette package labeling content, including 13 new rotating efficacy messages inside packs. The new messages were required for all manufactured packs by January 31, 2024, and, by April 31, 2024, for all packs sold. These efforts aim to re-engage smokers with novel messages to combat “wear out” of labeling effects as consumers become desensitized to their content (Thrasher et al., 2016a; Hitchman et al., 2014; Li et al., 2015).

The current study of Canadian adults who smoke assessed their responses to efficacy messages inside cigarette packs before and after implementation of new labeling content. In particular, we assessed changes in participants' self-reported reading/attention to the messages, perceived cessation benefits, self-efficacy to quit, and forgoing cigarettes. Furthermore, we investigated whether these responses were associated with subsequent quit attempts.

2. Methods

2.1. Sample

We used data from an open cohort of Canadian adults who smoke, of whom approximately 1500 were surveyed every three months between February 2023 and November 2024, with eight survey waves ($n = 12,022$ observations from 4716 participants). Leger, a Canadian online panel provider, recruited participants with the following eligibility criteria at study enrollment: being 18–100 years old; consumption of at least 100 cigarettes in one's lifetime; smoking at least once in the past month; and proficiency in English or French. The survey was administered in either language, depending on participant preference.

The open cohort study design encompassed both longitudinal follow-up and sample replenishment after the first baseline survey. Participants were re-invited to complete the subsequent survey, even if they had quit smoking since initial recruitment (average retention rate from one survey to the next = 68.5 %; range = 62 %–73 %), with new participants recruited to maintain a sample size of approximately 1,500 per wave. To enhance sample representativeness, soft quotas were implemented for age, sex, educational attainment, and province of residence, generally aligned with population distributions among Canadian adults. The study protocol received approval from the University of South Carolina Institutional Review Board (Protocol number: Pro00083728), and all participants provided informed consent prior to study enrollment and participation in subsequent surveys.

2.2. Measures

Our measures were mostly derived from previous research, adapting established PHWL questions to reflect messaging inside of packs (Fong et al., 2006). These adapted questions were pre-tested using cognitive interviewing among Canadian adults who smoke, with changes in wording re-assessed to confirm comprehension before baseline data collection.

Responses to inside-pack messages: Prior to answering questions about inside-pack messages, participants viewed a brief instructional video showing the exact location of the messages inside packs and directing them to not consider the labeling on the outside of packs (see Supplementary Fig. 1). Additionally, question wording reminded them to: “Think **ONLY** about the information printed on the back of the ‘slider’ that holds cigarettes **INSIDE** of packages...”

At each survey, participants reported their attention to inside-pack messages: “In the last 30 days – that is since [DATE ANCHORED TO ONE MONTH PRIOR TO ANSWERING SURVEY], how often **have you read** the health information **inside** of packages?” (Recoded to: “Never”/“Rarely” = reference vs “Sometimes”/“Often”/“Very often” due to small size concerns). The extent of perceived benefits from quitting due to inside-pack messages was assessed by asking “How much does the health information on the **inside** of packages make you feel like you would be **better off without smoking?**” (“Not at all”, “A little”, “Moderately”, “Very Much”, “Extremely”; when used as an independent variable in longitudinal analyses, “Very much” and “Extremely” were combined due to small sample sizes). Finally, participants were asked about forgoing cigarettes: “In the last 30 days, has the health information **inside** of packages **stopped you from having a cigarette** when you were about to smoke one? Would you say...” (Recoded as “Never” = reference vs “Once”/“A few times”/“Many times”). Before the section on pack labeling, participants were asked about their self-efficacy to quit smoking: “If you decided to give up smoking completely in the next 3 months, how **sure** are you that you would succeed?” (Same response options as for first two questions; due to sample size concerns in longitudinal analyses, recoded to: “Not at all”/“A little” = reference, “Moderately”, and “Very”/“Extremely”).

Quit Attempts: At each survey, participants reported whether they had made any attempts to stop smoking in the prior three months; those

who answered affirmatively reported the duration of their longest quit attempt during the prior three-month period. Participants who indicated that they had tried to quit and been abstinent for at least 24 h were considered as having tried to quit.

Covariates: We collected sociodemographic data on age (recoded to: 18–34 = reference, 35–49, 50–64, 65+), highest educational attainment (recoded to: high school or less = reference, technical school, college or more), and race/ethnicity (recoded to: White vs other). Smoking-related variables included: nicotine dependence, measured using the Heaviness of Smoking Index (range = 0–6), which combines smoking frequency with time from waking to smoking the first cigarette of the day (Heatherton et al., 1989); past 30 day use of roll-your-own tobacco (recoded as Any vs None); past 30 day use of each of e-cigarettes, cigars, cigarillos, pipes, chewing tobacco, oral nicotine products (any use vs no use for each product); and intentions to quit smoking within the next six months (recoded to: yes vs no or don't know).

2.3. Analysis

Our analyses involved two analytic samples. The first included all observations to analyze trends in each of the four message response variables over time. We excluded participants who had quit smoking at the time of the survey ($n = 302$ participants, 535 observations) because they were not asked questions of interest, as well as observations with “don't know” or “refused” responses to key outcomes and independent variables (reading inside-pack messages: $n = 191$ observations, 1.6 %; perceived cessation benefits: $n = 495$ observations, 4.3 %; forgoing cigarettes: $n = 688$ observations, 5.7 %; self-efficacy to quit: $n = 317$ observations, 2.7 %). We used Generalized Estimating Equations (GEE) with exchangeable correlation structure and robust standard errors to account for repeated measurements. Post-estimation commands were used to generate means/proportions for each wave, while adjusting for covariates (see Measurement). To evaluate potential policy effects, these GEE models were re-estimated after re-coding survey waves into the pre-policy period (Waves one through four: February–November 2023 = reference group) with two specifications for the post-policy period: (1) including the initial implementation phase (Waves five through eight: February 2024–November 2024) and (2) including only data after full policy implementation (Waves six through eight: May 2024–November 2024). Linear GEE models were estimated for continuous outcomes (self-efficacy to quit, perceived benefits) and logistic GEE models for binary outcomes (reading, forgoing, and quit attempts). We conducted sensitivity analyses using multiple imputation with chained equations to address missingness.

The second analytic sample included participants who answered at least two consecutive survey waves ($n = 6,959$ observations from 2,356 individuals). We excluded observations with incomplete data for key independent variables (reading = 185, 1.6 %; forgoing = 235, 2.1 %; benefit perception = 413, 5.9 %; self-efficacy = 209, 3.0 %). We estimated mixed-effects logistic models regressing having engaged in a quit attempt by the subsequent survey (at time $t + 1$) on inside-pack message-response variables (including self-efficacy to quit) measured at the prior wave (at time t). We estimated crude and adjusted associations, with each message response variable assessed in separate models, to confirm that each message-response variable has predictive validity for cessation outcomes. For the trend analyses, we used both specifications for the post-policy period. Like the trend analysis, we conducted sensitivity analyses using multiple imputation with chained equations to integrate observations with missing values. We also re-ran models using the same recoding as in the trend analysis (e.g., dichotomizing reading frequency, treating perceived benefits and self-efficacy to quit smoking as continuous instead of as dummy variables).

All analyses applied post-stratification weights derived from the 2021 Canadian Community Health Survey's nationally representative estimates of the distribution of sex, age, and educational attainment among adults who smoke, calculating separate weights for each of the

two analytic samples. Analyses were conducted using Stata 18, with statistical significance set at $p < 0.05$.

3. Results

Table 1 shows the weighted and unweighted characteristics of each analytic sample. Approximately, one fifth of the sample completed only one survey (20.5 %) and one quarter (23.5 %) completed all eight surveys. Most participants were aged 35–64 years (60.9 %), male (55.8 %), and identified as White (81.8 %). Most participants reported smoking daily (73.8 %), and approximately one-third (35.7 %) indicated intentions to quit smoking within six months.

3.1. Time trends and pre-post comparisons of inside-pack message responses

Weighted, adjusted estimates of the means/proportions for each outcome at each wave are shown in Figs. 1a-d. In models that included the post- vs. pre-policy contrast presented in Table 2, reading inside-pack messages increased significantly in the post-policy period compared to the pre-policy period, whether including data from the early implementation survey in February 2024 (AOR = 1.18, 95 %CI = 1.04, 1.34) or excluding it (AOR = 1.22, 95 %CI = 1.06, 1.41). The strength of perceived benefits from quitting due to inside-pack messages also increased significantly post-policy ($\beta_{adj} = 0.07$, 95 %CI = 0.01, 0.12 including February 2024; $\beta_{adj} = 0.09$, 95 %CI = 0.03, 0.16 excluding February 2024). Similarly, forgoing cigarettes due to inside-pack health information was higher in both post-policy periods compared to the pre-policy period (AOR = 1.14, 95 %CI = 1.01, 1.28; AOR = 1.19, 95 %CI = 1.03, 1.37 respectively). Finally, self-efficacy to quit smoking also increased in both post-policy periods ($\beta_{adj} = 0.08$, 95 %CI = 0.04, 0.13; $\beta_{adj} = 0.10$, 95 %CI = 0.04, 0.16 respectively). No significant differences in quit attempts were observed in the post-policy period compared to the pre-policy period (AOR = 1.09, 95 %CI = 0.97, 1.23 including February 2024; AOR = 1.11, 95 %CI = 0.97, 1.27 excluding February 2024). Results of sensitivity analyses (Supplementary Table 1) were consistent with the results presented here.

3.2. Inside-pack message responses as predictors of quit attempts by the subsequent survey

Reading inside-pack messages showed a dose-response relationship with subsequent quit attempts. Compared to those who never read the information, participants who rarely read it (AOR = 1.71, 95 %CI = 1.36, 2.15) and those who read the messages sometimes or more frequently (AOR = 2.01, 95 %CI = 1.53, 2.63) were more likely to attempt quitting. Perceived benefits from quitting due to inside-pack messages also showed a dose-response relationship with quit attempts, where the strongest association emerged with reporting the highest levels of perceived benefits (AOR = 2.66, 95 %CI = 2.06, 3.44 for very much/extremely vs. not at all). Participants who reported forgoing cigarettes due to inside-pack messages were more likely to attempt quitting compared to those who did not (AOR = 1.88, 95 %CI = 1.48, 2.37). Similarly, higher self-efficacy to quit was associated with a greater likelihood of attempting to quit, with those who felt very or extremely sure about their ability to quit being most likely to attempt (AOR = 2.06, 95 %CI = 1.53, 2.78) compared to those who were not sure or only a little sure. Sensitivity analyses using multiple imputation and different recoding methods yielded consistent statistical significance of the results (Supplementary Table 2 and Table 3).

4. Discussion

This evaluation of Canada's 2024 updated tobacco labeling policy – which included eight new rotating inside-pack efficacy messages about cessation benefits and tips – provides evidence of its effectiveness.

Table 1
Descriptive statistics of the sample of Canadian adults who smoke, 2023–2024.

Characteristics		Entire Sample ¹		Longitudinal Sample ²	
		Unweighted %	Weighted %	Unweighted %	Weighted %
Age	18–34	25.3	23.8	18.5	23.5
	35–49	27.5	27.8	27.6	27.8
	50–64	32.5	33.1	36.1	33.4
	65+	14.8	15.3	17.8	15.4
Sex	Female	49.9	44.2	48.5	44.4
	Male	50.1	55.8	51.5	55.6
Race	White	80.2	81.8	82.1	83.5
	Other	19.8	18.2	17.9	16.5
Education	High school or less	38.1	43.9	35.4	43.7
	Technical school	39.1	39.6	40.0	39.8
	College or more	22.9	16.5	24.6	16.5
Smoking frequency	Daily	73.4	73.8	76.2	74.2
	Nondaily	26.6	26.2	23.8	25.8
Heaviness of smoking Index ³	Mean (SE)	2.16(1.58)	2.19(1.60)	2.23(1.58)	2.20(1.59)
	[range = 0–6]				
Quit intention ⁴	(in next six months)	36.9	35.7	35.0	35.1
Roll-your-own use	(any in last 30 days)	22.1	21.3	20.1	20.5
E-cigarette use	(any in last 30 days)	21.4	21.3	19.6	21.2
Other tobacco use	(any in last 30 days)	20.5	19.8	17.5	18.0
Survey wave	One (Feb 2023)	13.1	13.1	14.3	14.3
	Two (May 2023)	12.7	12.7	13.0	13.0
	Three (Aug 2023)	12.6	12.6	14.7	14.7
	Four (Nov 2023)	12.6	12.6	14.7	14.7
	Five (Feb 2024)	12.3	12.3	13.9	13.9
	Six (May 2024)	12.3	12.3	14.7	14.7
	Seven (Aug 2024)	12.2	12.2	14.7	14.7
	Eight (Nov 2024)	12.3	12.3	N/A ⁵	N/A ⁵
				N/A ⁶	N/A ⁶
Number of surveys completed	One	20.5	20.5		
	Two	13.4	13.4	11.6	11.6
	Three	10.1	10.1	11.2	11.2
	Four	10.0	10.0	12.4	12.4
	Five	8.6	8.6	11.4	11.4
	Six	8.3	8.3	11.5	11.5
	Seven	5.6	5.6	8.0	8.0
	Eight	23.5	23.5	34.1	34.1

¹ n = 11,487 observations in the table from 4716 individuals;

² n = 6959 observations shown in the table from 2365 individuals;

³ Heaviness of Smoking Index combines scores for smoking frequency and time from waking to first cigarette of the day (Heatherton et al., 1989);

⁴ Quit intention measured by asking “Are you planning to quit smoking ...” (recoded as: beyond the next six months or no intention to quit = 0; within the next six months = 1);

⁵ Not applicable because survey wave seven data (t) used to predict quit attempts by subsequent survey wave eight (t + 1);

⁶ Not applicable because participant had to be surveyed in at least 2 consecutive waves to be included in the analysis; those who completed only one survey were excluded from the analysis.

Following implementation, Canadian adults who smoke reported greater engagement with these messages across multiple indicators: more frequent reading of inside-pack messages, stronger perceptions of cessation benefits and more forgoing due to the messages, and greater self-efficacy to quit smoking. This is consistent with other observational studies, showing that rotating new cigarette warning labels on the outside of packs increases desired psychosocial and behavioral effects (Noar et al., 2016), likely because of the novelty of new content, as well as formatting, that can re-engage consumers. Furthermore, we found that these responses to inside-pack efficacy messages predicted subsequent smoking cessation attempts, as expected from theory and prior empirical evidence, confirming their utility for predicting important behavioral outcome (Lambert et al., 2018; Lambert et al., 2024; Thrasher et al., 2015; Thrasher et al., 2016a).

Compared with the pre-policy period, Canadian adults who smoked reported more frequent reading of inside-pack messages after they were updated, in line with prior research on changing outside pack labels to enhance consumer attention toward them (Moodie, 2018). These findings reinforce the importance of rotating message content, particularly given evidence from a randomized clinical trial that attention toward labels mediates the effects of inside-pack efficacy messages on psychosocial and behavioral precursors to quitting (Lambert et al., 2024). Indeed, we found that more frequent reading of inside-pack efficacy

messages independently predicted subsequent quit attempts, as in other research (Thrasher et al., 2015; Thrasher et al., 2016a). Canada’s 2020 standardized packaging policy mandated that all packs be “slider” packs, with the inside-pack messages being printed on the back of the slider, as opposed to the removable inserts (small sheets of paper) that were inside previously allowed flip-top packs, as well as in randomized trials (Lambert et al., 2018; Thrasher et al., 2024; Lambert et al., 2024). The location of the messages on the back of the slider is relatively easy to ignore and inconvenient for smokers to read (see Supplementary Fig. 1). In 2026, Canada will move the inside-pack messages to an extended upper flap on the slider, which could increase message engagement. Future research should evaluate this change.

Implementation of new inside-pack messages was associated with increases in psychological predictors of cessation reflected in the primary content of these messages – namely perceptions of cessation benefits (response efficacy) and confidence in the ability to quit (self-efficacy) – were higher in the post-policy period. These results are consistent with experimental evidence from randomized trials where exposure to pack inside-pack inserts with efficacy messages was associated with stronger efficacy beliefs (Lambert et al., 2018; Lambert et al., 2024), though another study found null effects (Thrasher et al., 2024). These psychological constructs are central to behavioral change theories and promote cessation success (Andrews et al., 2007; Brandon et al.,

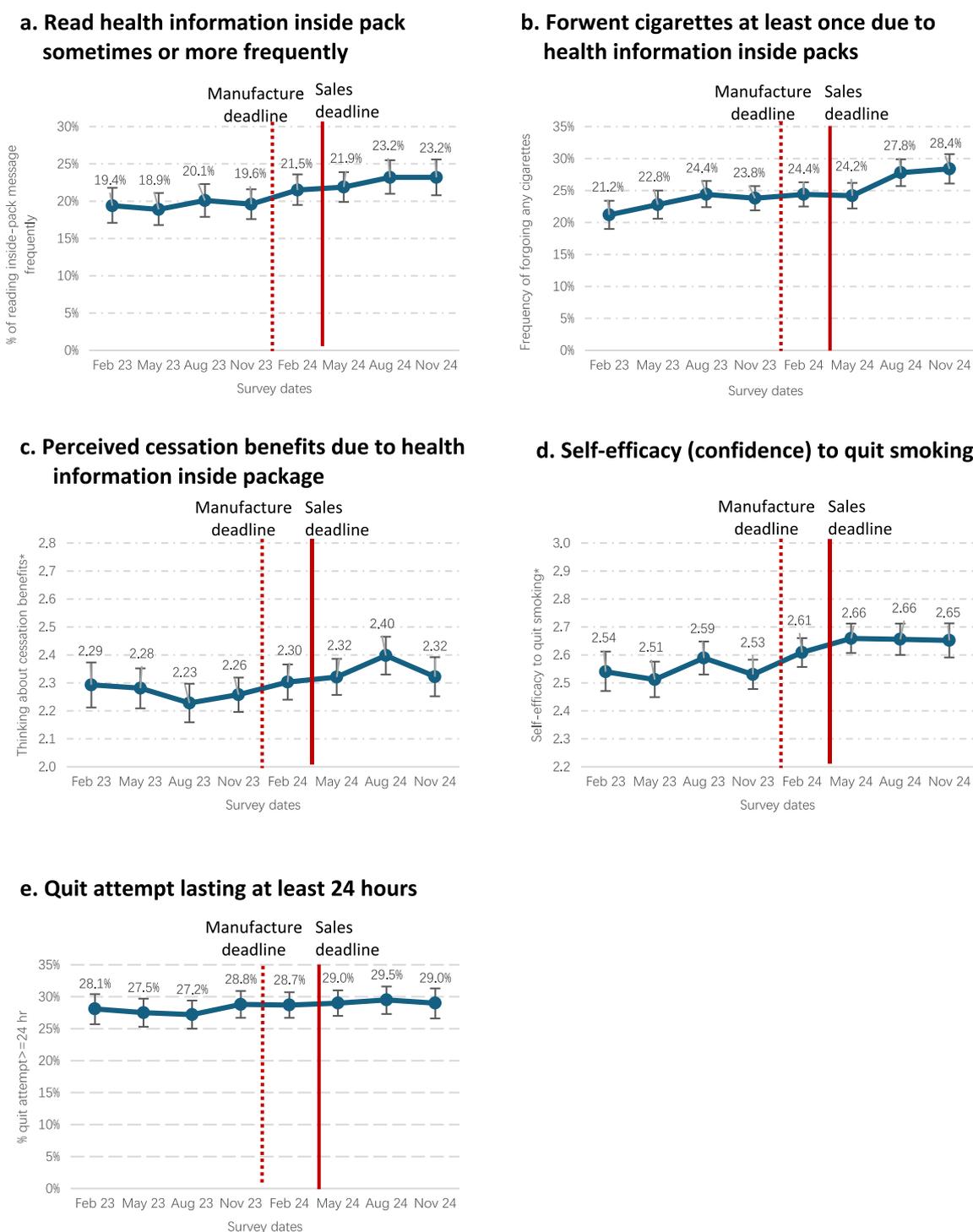


Fig. 1. Trends¹ in responses to inside-pack health information among Canadian adults who smoke before, during, and after implementation of new content for cigarette package labels, 2023–2024

¹Values shown on graphics are point estimates at each survey wave from weighted models that adjust for sex, age, education, Heaviness of Smoking Index, roll your own tobacco use, other tobacco product use, e-cigarette use, quit intentions, and time in sample (i.e., number of previous surveys completed at the time of survey administration).

1990; O’Hea et al., 2004; Cinciripini et al., 2003; Thrasher et al., 2016b), consistent with our findings that they predicted quit attempts over three-month periods, expanding experimental evidence from one- to two-week trials, as well as observational research that did not include pre-policy assessments (Thrasher et al., 2016a).

In the post-policy period, more participants reported forgoing cigarettes they would normally smoke – a consistent predictor of subsequent cessation attempts (Partos et al., 2014; Borland et al., 2009b), including in this study – because of the inside-pack messages. This pattern aligns with previous experimental research on how inside-pack messages,

Table 2
Pre- vs post-policy responses to inside pack health information among Canadian adults who smoke, 2023–2024.

	Frequency of reading health information inside packs ³		Forwent cigarettes due to inside-pack messages ⁴		Perceived benefits of quitting due to inside-pack messages ⁵		Self-efficacy (confidence) to quit smoking ⁶	
	OR (95 % CI)	AOR ⁷ (95 % CI)	OR (95 % CI)	AOR ⁷ (95 % CI)	B (95 % CI)	B _{adj} ⁷ (95 % CI)	B (95 % CI)	B _{adj} ⁷ (95 % CI)
Post- (2024, manufacturer deadline ¹) vs pre-policy (2023)	1.24 (1.14, 1.35)	1.18 (1.04, 1.34)	1.20 (1.12, 1.29)	1.14 (1.01, 1.28)	0.09 (0.05, 0.14)	0.07 (0.01, 0.12)	0.04 (0.00, 0.08)	0.08 (0.04, 0.13)
Post- (2024, all packs sold deadline ²) vs pre-policy (2023)	1.27 (1.16, 1.4)	1.22 (1.06, 1.41)	1.26 (1.16, 1.36)	1.19 (1.03, 1.37)	0.11 (0.06, 0.17)	0.09 (0.03, 0.16)	0.03 (−0.01, 0.08)	0.10 (0.04, 0.16)

¹ Post- (Feb 2024–Nov 2024) vs. Pre-policy (Feb 2023–Nov 2023); January 31, 2024 = Manufacturer deadline.

² Post- (May 2024–Nov 2024) vs. Pre-policy (Feb 2023–Nov 2023), excluding data from February 2024 survey; April 31, 2024 = Retail sales deadline.

³ 1-reading inside-pack messages sometimes or more frequently vs 0-never reading inside-pack messages or rarely reading; estimates shown are Odds Ratios from logistic regression with generalized estimating equations (GEE).

⁴ 1-Any forgoing in prior month vs 0-no forgoing; estimates shown are Odds Ratios from logistic GEE regression.

⁵ 1-Not at all to 5-Extremely; estimates shown are betas from linear GEE regression.

⁶ 1-Not at all sure to 5-Extremely sure; estimates shown are betas from linear GEE regression.

⁷ Adjusted for sex, age, education, Heaviness of Smoking Index, roll your own tobacco use, other tobacco product use, e-cigarette use, quit intentions, and time in sample (i.e., number of previous surveys completed at the time of survey administration).

some of which include content about delaying cigarettes as a step toward cessation, can promote forgoing (Lambert et al., 2018; Thrasher et al., 2024). We found this association even though Canada's messages did not explicitly promote forgoing, though increased forgoing is also associated with newly implemented PHWLs that also do not mention forgoing. More research is needed to determine which inside-pack efficacy messages best promote sustained cessation. Indeed, while the Canadian labeling policy update appears to have increased engagement with inside-pack efficacy messages, the strength of association between these message responses and cessation attempts was similar across the pre and post policy periods. Additional communication efforts through channels beyond the pack may be needed to increase label messaging effects.

Although our results indicate significant increases in all responses to inside-pack message following the implementation of new messages, the overall magnitude of these effects was relatively modest when compared to studies where PHWLs are introduced for the first time or when PHWL size was increased and plain packaging introduced when also changing PHWL content (Noar et al., 2016; Nagelhout et al., 2015). For instance, the frequency of reading inside-pack messages rose by only about 4 % - and attention to messages is a critical gateway for cigarette labeling effects (Lambert et al., 2024; Noar et al., 2016). Despite increased responsiveness to inside-pack efficacy messages following policy implementation and their positive associations with subsequent quit attempts, quit attempts themselves did not significantly increase over time. After more than 20 years of repeated exposure to PHWLs and inside-pack messages, the relatively small changes in message responses after implementation of new content may reflect “message fatigue” – or a sense of exhaustion and boredom due to having viewed too many messages perceived as containing redundant information (Keating and Skurka, 2024). Despite the modest population-level magnitude of changes in responses to the new messages, even these incremental gains can result in meaningful public health benefits, especially given the high population burden of tobacco use.

Our study has some limitations, including the generalizability of results due to our use of a convenience sample. Although we used target quotas and weighting of the sample to the general population of Canadian smokers, over-representation of certain groups, such as older adults and those with lower quit intentions, may have resulted in some biases. However, these biases may have led to underestimates of inside-pack message rotation effects given that these groups' typically show lower sensitivity to warning label policies (Thrasher et al., 2015; Thrasher et al., 2018; Loud et al., 2021). The detection of policy effects remains noteworthy given that our sample appeared to over-represent Canadians with no intention to quit within the next six months (Gravelly et al., 2023), a predominant subgroup of people who smoke among whom interventions have limited impact and are sorely needed (Klemperer et al., 2022). Despite replenishing the sample at each wave, we were unable to evaluate sustained cessation behaviors due to their relatively rare occurrence in our sample and the resulting small sample sizes. Future research with nationally representative samples should evaluate changes in smoking prevalence, although distinguishing the specific effects of insert messages may be challenging given the simultaneous implementation of new PHWLs on the outside of packs, warnings on cigarette sticks themselves, and a cigarette tax increase. For example, during our study Canada implemented the first-ever warnings printed on cigarette sticks (i.e., mandated for king-size cigarettes manufactured after April 30, 2024, and sold after July 31, 2024), a policy that has shown to promote precursors of quit attempts (Thrasher et al., 2025). Our study aimed to distinguish responses to these other policies by using questions specific to the efficacy information inside packages, with questions following a required video to anchor participants' recall to inside pack messages. Cigarette stick warnings communicate smoking risk information that promotes cessation primarily by eliciting cognitive elaboration of risks and negative affect (e.g., fear), domains that were not reflected in our questions about inside-pack messages. Nevertheless,

Table 3

Responses to inside-pack efficacy messages (time t) and quit attempts at the subsequent survey (time t + 1) among Canadian adults who smoke, 2023–2024.

Independent variables		Quit attempt at time t + 1 wave % ¹	OR (95 % CI)	AOR ² (95 %CI)
Read health information inside packs	Never	19	1.00	1.00
	Rarely	33	2.53 (1.90, 3.37)	1.71 (1.36, 2.15)
	≥sometimes	45	4.12 (2.97, 5.73)	2.01 (1.53, 2.63)
Forwent cigarettes due to inside-pack messages	Never	21	1.00	1.00
	≥once	50	3.85 (2.93, 5.07)	1.88 (1.48, 2.37)
	Not at all	17	1.00	1.00
Perceived cessation benefits due to inside-pack messages	A little	25	2.42 (1.78, 3.29)	1.78 (1.38, 2.29)
	Moderately	34	2.94 (2.16, 4.00)	1.68 (1.28, 2.19)
	Very & extremely	43	5.17 (3.76, 7.12)	2.66 (2.06, 3.44)
Self-efficacy (confidence) to quit smoking	Not at all & A little	17	1.00	1.00
	Moderately	35	2.59 (1.97, 3.42)	1.50 (1.20, 1.89)
	Very & extremely	44	4.84 (3.25, 7.22)	2.06 (1.53, 2.78)

¹ Weighted proportions for the percentage of people in the row who attempted to quit by subsequent survey wave (time t + 1).

² Adjusted for sex, age, education, Heaviness of Smoking Index, roll your own tobacco use, e-cigarette use, other tobacco product use, quit intentions, survey wave, and time in sample (i.e., number of previous surveys completed at the time of survey administration).

participants' responses may still have been influenced by these concurrent policy changes. Finally, some of our questions involved attribution of thoughts (perceived cessation benefits) and behaviors (forgoing) to inside-pack messages, which could have amplified apparent policy effects if testing (survey wording) by treatment (message changes) interactions occurred. Changes in forgoing and perceived cessation benefits without reference to inside-pack messages may have been caused by other labeling and policy elements. Nevertheless, we found evidence of post-policy increases for self-efficacy to quit, which inside-pack messages more specifically target, even though our measure did not involve attribution to these messages.

This study provides evidence that Canada's 2024 update to inside-pack efficacy messages was associated with increased engagement and desired cessation-related responses among adults who smoke. Despite modest effect sizes, these findings highlight the importance of periodically updating inside-pack efficacy message content to sustain smoker engagement and promote cessation behaviors. As the only country that has implemented inside-pack efficacy messages, Canada's experience offers valuable insights for other jurisdictions considering strategies to enhance the effects of their labeling policy, including after implementation of PHWLs. Future research should examine the long-term impact of such policy updates, including after Canada relocates these messages to more prominent placement within packages and, thereby, potentially augmenting their effectiveness.

CRediT authorship contribution statement

Yanwen Sun: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Desiree Vidana-Perez:** Writing – review & editing. **Jeff Niederdeppe:** Writing – review & editing. **Minji Kim:** Writing – review & editing. **Chih-Hiang Yang:** Writing – review & editing. **Emily Hackworth:** Writing – review & editing. **David Hammond:** Writing – review & editing. **James F. Thrasher:** Writing – review & editing, Writing – original draft, Resources, Project administration, Funding acquisition.

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Declaration of competing interest

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. SFG has provided expert advice to various pharmaceutical companies on matters related to smoking cessation, and he has also received researcher-initiated project grant funding and travel funds. These companies are not involved in the current study. Otherwise, the authors have no conflicts or potential conflicts of interest to report.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ypmed.2025.108347>.

Data availability

Data will be made available on request.

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