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Which type of tobacco product warning imagery is more effective and sustainable over time? A longitudinal assessment of smokers in Canada, Australia, and Mexico

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Objective. This study examined smokers' responses to pictorial health warnings (PHWs) with different types of imagery under natural exposure conditions.

Methods. Adult smokers from online panels in Canada (n=2,357), Australia (n=1,671) and Mexico (n=2,537) were surveyed every four months from 2012 to 2013. Participants were shown PHWs on packs in their respective countries and asked about: 1) Noticing PHWs; 2) Negative affects toward PHWs; 3) Believability of PHWs; 4) PHW-stimulated discussions; and 5) Quit motivation due to PHWs. Country-specific generalized estimating equation models regressed these outcomes on time (i.e., survey wave), PHW imagery type (i.e., symbolic representations of risk; suffering from smoking; graphic depictions of bodily harm), and interactions between them.

Results. In all countries, PHW responses did not significantly change over time, except for increased noticing PHWs in Canada and Mexico, increased negative affect in Australia, and decreased negative affect in Mexico. For all outcomes, symbolic PHWs were rated lower than suffering and graphic PHWs in Canada (the only country with symbolic PHWs). Graphic PHWs were rated higher than suffering PHWs for negative affect (all countries), discussions (Canada), and quit motivation (Australia). Suffering PHWs were rated higher than graphic PHWs for noticing PHWs (Canada), believability (all countries), discussions (Australia & Mexico), and quit motivation (Mexico). Changes in noticing, believability and discussions varied somewhat by imagery type across countries.

Conclusions. The different PHW imagery appears to have different pathways of influence on adult smokers. Reactions to specific PHWs are similar over 1-2 years, suggesting that wear-out of PHW effects is due to decreased attention rather than the diminishing effectiveness of content.

Keywords: policy; tobacco control; communication; graphic warning

Strengths and limitations of this study

- Longitudinal assessment of smokers' responses under naturalistic, repeated exposure to PHWs can help to understand how different types of PHW imagery works over time.
- This study used measures of affective, cognitive and motivational responses of smokers exposed to PHWs with different types of imagery which may help understand the mechanisms for changes in responses over time.
- Other population-based studies have involved recalled impact of PHWs, while this study presented specific PHWs that were on packs at the time of the survey, which may help separate out potential habituation to the PHW message itself from the effects of attention toward PHWs.
- The differences in stimuli by country and within each category, and in some cases within country over time, limit the interpretations around cross-country comparisons.
- Data for this study came from an online consumer panel which may limit the ability to generalize the results to the broader population of smokers.

INTRODUCTION

The World Health Organization's Framework Convention on Tobacco Control recommends that countries implement multiple, prominent pictorial health warnings (PHWs) to communicate about tobacco-related diseases.[1] Over 70 countries have implemented PHWs using a great variety of messages and imagery.[2] Previous experimental studies have shown that compared to the text-only warnings, PHWs are more salient,[3] believable,[4] elicit stronger negative affect, and more likely to motivate cessation.[5–7] Although observational studies indicate that all forms of PHW regimens lose their effectiveness over time,[8] the mechanisms for wear-out are uncertain, as are the conditions under which wear-out might be reversed. In particular, it is not clear whether wear-out effects are because smokers become inured to PHW messages or are just less likely to attend to them. Further, of the wide variety of imagery used in PHWs, no studies of which we are aware have examined whether some types of imagery work best over time.

Based on the fear appeal theory, the effects of messages vary with the level of gruesome content or with the level of negative reaction elicited from the messages.[9,10] Thus, the imagery used in PHWs can be classified according to the level of gruesome content (i.e., from the most frightening to the least frightening), and negative affect such as disgust can explain audience reaction to PHWs.[11] Some experimental studies have examined responses to different types of pictorial imagery on PHWs,[12–16] generally classifying PHW imagery into three main categories: 1) Graphic: Vivid depiction of negative health consequences or physical effects of smoking; 2) Suffering: Portrayal of personal experiences living with smoking-related diseases, including negative impacts on quality of life; and 3) Symbolic: Abstract or metaphorical representations of the negative effects of smoking. Previous experimental studies have consistently indicated that PHWs with graphic imagery elicit relatively stronger attentional, cognitive and behavioral

responses.[12,13,17,18] Furthermore, data from functional magnetic resonance imaging found that the levels of activation of different neural regions involved in image interpretation and emotion varied in a manner consistent with self-reported ratings of different PHWs imagery types.[15] Nevertheless, prior evidence on the superiority of certain types of images mainly came from pre-market experimental studies, and there is very little research on the validity of pre-market experiments for determining pictorial warning content that is most effective after policy implementation. Longitudinal studies of smokers' responses under naturalistic, repeated exposure to PHWs are needed to understand how different imagery works over time. Our study aimed to fill that gap by embedding specific warning rating methods used in experimental research into a longitudinal study design of consumer responses post-implementation of new warnings.

Study Context

Canada pioneered PHWs, implementing its first round in June 2001 with a set of 16 PHWs that covered 50% of the front and back of cigarette packs. In 2012, a new set of 16 PHWs were implemented, covering 75% of the front and back of packs. In March 2006, Australia implemented its first PHWs, which covered 30% of the front and 90% of the back of cigarette packs. In December 2012, Australia introduced a new set of PHWs, rotating seven new PHWs each year, and pioneered standardized packaging that required all tobacco products be sold in dull, brown packages, with the same font and without company logos. Mexico first implemented PHWs in September 2010, requiring PHWs that covered 30% of the front and a text-only warning covering 100% of the back. Since 2012, four new PHWs were implemented every six months.

Using longitudinal data collected from adult smokers in Canada, Australia and Mexico, this study sought to examine: a) the affective, cognitive and motivational responses of smokers exposed to PHWs with different types of imagery (i.e., graphic, suffering, and symbolic); b) whether these responses changed over time; and c) whether the changes in responses over time depended on types of imagery. Other population-based studies have involved recalled impact of PHWs, in general; by contrast, this study presented specific PHWs that were on packs at the time of the survey, and queried smokers' ratings of these at the time of survey. This approach helps separate out potential habituation to the PHW message itself from the effects of attention toward PHWs.

METHOD

Patient and Public Involvement

This study did not involve patients nor the public as participants. Our study participants came from a consumer panel used for market research, all contact with participants was managed by a private company (GMI Lightspeed), and datasets we received did not include any information that would allow us to identify participants.

Sample

Data for this study came from an online consumer panel of adult smokers followed up every four months in Canada, Australia and Mexico who were 18 to 64 years old, had smoked 100 or more cigarettes in their lifetime, and had smoked at least once in the previous month. Sample size in each country was approximately 1,000 at each wave, with replenishment sampling used to maintain sample size across waves and to reduce the attrition bias. For this study, the analytic sample included only current smokers at each wave (see Table 1) as ex-smokers were less likely to be exposed to PHWs. Additionally, to be comparable, only data from

post-implementation period in each country were included in the analysis (i.e., in Canada and Mexico: 4 survey waves from September 2012 to September 2013; in Australia: 3 survey waves from January 2013 to September 2013). Reporting of this study adhered to the STROBE guidelines (Appendix 1).

Materials

PHWs used as stimuli varied across countries depending on the actual PHWs implemented in each country. To reduce participant burden, participants were presented with only a subset of PHWs that appeared on cigarette packs in their respective country during the study period. Each participant was presented and asked to rate each of the PHWs in the subset. PHWs were selected to maximize the number with shared topical foci across countries. Of the 16 PHWs on the market in Canada, we selected eight for our study (three suffering; three graphic; two symbolic). We also selected eight PHWs for Australia and Mexico; however, two of the PHWs for Australia were implemented after the study period, resulting in six PHWs analyzed for this study (i.e., two PHWs with suffering imagery and four PHWs with graphic imagery). Four new PHWs were introduced every six months in Mexico, where regulations do not require that packs with PHWs from prior rounds; Surveys in Mexico integrated some new PHWs while deleting others over time, resulting in 10 stimuli for this study (i.e., four PHWs with suffering imagery and six PHWs with graphic imagery; see Figure 1 for all stimuli used in this study by country and imagery type). PHW stimuli were presented in random order to account for ordering effects, and participants were asked a set of questions after viewing each of the stimuli.

Measures

Main outcomes

Participants were asked about five topical domains for each PHW assessing affective, cognitive and motivational responses that have been shown to be important mediators for warning label impact.[7,19,20] Noticing PHW was assessed using one item (i.e., "In the last month, how often have you seen this warning on the cigarette packs that you buy?"), with responses ranging from 1 (never) to 5 (very often). Due to a skewed distribution, responses were dichotomized with 0 for those who answered never, and 1 for those who answered once to very often. Negative affect was measured using three items (i.e., "How much does this warning make you feel afraid?"; "How disgusting is this warning label?"; and "How much does this warning make you feel worried about the health risks of smoking?") to which participants indicated agreement using a nine-point response scale with "not at all" and "extremely" at scale endpoints. Responses of these items were averaged to form a scale (range of Cronbach's alpha across PHWs in Canada=0.86–0.91; Australia=0.86–0.93; Mexico=0.78–0.85). Message believability was measured using a single item (i.e., "How believable is this warning?"), and so was quit motivation (i.e., "How much does this warning make you want to quit smoking?"), with both using a 9-point response scale, as above. Lastly, discussion about warning in the past month was assessed (i.e., "In the last month, have you talked with anyone about this warning?"), with a "yes" or "no" answer.

Independent variables

Each PHW was classified by type of imagery used (i.e., graphic, suffering, and, in Canada only, symbolic), using dummy coding with suffering imagery as the reference group. We created dummy variables for survey waves ranging from wave 1 to wave 4 for Canada and Mexico (with wave 1 as the reference), and from wave 2 to wave 4 for Australia (with wave 2 as the reference).

Adjustment variables

Adjustment variables included socio-demographic and smoking relevant variables. Socio-demographic variables included age group (18-24; 25-34; 35-44; 45-54; 55-64), gender, educational level (high school or less; some college or university; and completed university or higher), annual household income (Australia and Canada: $29,999 or less, $30,000-$59,999, and $60,000 or more; Mexico, monthly income, in pesos: $5,000 or less, $5,001-$10,000, and $10,001 or more), and race (for Canada only, white and non-white). Smoking-relevant variables included nicotine dependence, using the Heaviness of Smoking Index (HSI) that combined the number of cigarettes smoked per day and time to first cigarette of the day.[21,22] Intention to quit was measured by asking about plans to quit smoking (within the next month; within the next 6 months; sometime in the future, beyond 6 months; not planning to quit; don't know), with responses dichotomized to reflect intentions to quit smoking within the next month or six months versus other responses. Recent quit attempts were measured by asking if participants have made a quit attempt in the prior 4 months. Additionally, to control for possible instrumentation effects due to prior survey participation, we also assessed and created dummy variables for the number of prior surveys completed by participants, using their first participation as the reference.

Data analysis

All analyses were conducted using Stata version 12, and were conducted separately by country due to the different PHWs assessed across countries. Each PHW was treated as a separate observation. To adjust for the correlated nature of the data and to maximize the number of cases available for analysis, generalized estimating equation (GEE) models with an exchangeable correlation matrix were used to compute parameter estimates. Separate bivariate and adjusted GEE models were estimated to assess the main effects of survey wave and PHW

imagery type on each of the outcomes. To assess linearity of trends over time, survey wave was treated as a continuous variable while controlling for adjustment variables; then a quadratic term (wave squared) was added to test for any nonlinearity in trends. For the final models, survey wave was treated as a categorical variable, and interaction terms between imagery type and survey wave were added into the models to test whether the patterns of change over time in outcomes of interest varied by PHW imagery type. Adjusted models included socio-demographics, smoking-related variables and time-in-sample. We also conducted some sensitivity analyses: First, for all models, we included variables to control media exposure that may coincided with PHW implementation that could also affect our study outcomes. The results were the same in terms of direction, magnitude and statistical significance. Second, we conducted sensitivity analyses with models regressing noticing PHWs as a continuous variable and as a dichotomous variable with different cut point, and regressing negative affect with the three original variables. Results were mostly consistent in terms of direction, magnitude, and statistical significance.

RESULTS

Sample Characteristics

Sample characteristics by country and survey wave are shown in Table 1. In baseline samples, over half of participants were women in Canada and Australia, while the reverse was true in Mexico. Most Mexican participants had some college or higher level of education, while about one third of Canadian and Australian participants had high school or less education. Compared to Canadian and Australian participants, Mexican participants were also younger, and had more non-daily smokers. The proportion of smokers who reported having attempted to quit was lower among Australian participants than those in Canada and Mexico.

Changes of PHW Responses Over Time

Noticing PHWs

We dichotomized responses to 0 for those who answered never versus 1 for those who answered otherwise. Most respondents saw the warnings in the last month (55%-64% in Canada, 79%-82% in Australia, and 72%-81% in Mexico; see Appendix 2). In the adjusted model for Australia, no change in noticing PHWs over the study period was observed (p-value=0.528), with no statistically significant interaction to indicate a different pattern by imagery type. By contrast, noticing PHWs increased over the study period in both Canada and Mexico. In Canada, this increase was in a linear fashion (p-value=0.019) whereas in Mexico the trend was non-linear (quadratic trend p-value=0.004, Figure 2A). Main effects of imagery type on noticing PHWs also showed differences across countries. In Canada, symbolic images were less likely to be noticed than the suffering images and the graphic images (Table 2). Compared to the suffering images, graphic images were less likely to be noticed in Canada, but not in Australia or Mexico where no difference was observed (Table 2). A significant interaction between wave and imagery type was observed in Mexico suggesting the differences between PHWs with graphic and suffering images were significantly greater in the fourth waves (χ^2=14.93, p-value=0.027, Figure 2A).

Negative affect

Ratings of negative affect elicited by PHWs showed different patterns of results across the three countries (Table 2). For main effects of survey wave, negative affective responses did not change in Canada, increased in Australia (p-value=0.027), and declined in Mexico (p-value=0.044). No differences in these trends were found by imagery type. Graphic PHWs were rated higher than suffering PHWs on negative affect in Canada, Australia, and Mexico. Canadian symbolic PHWs were rated lower on negative affect than suffering and graphic PHWs (Table 2).

Believability

Adjusted models indicated no significant change in believability of PHWs over time in Canada (p-value=0.812), Australia (p-value=0.162), and Mexico (p-value=0.247). Compared to the suffering images, graphic images were rated lower on believability in Canada, Australia, and Mexico (Table 2). Also, in Canada, symbolic images were rated lower on believability than suffering and graphic images. A significant wave by imagery type interaction was observed in Canada (χ^2=13.28, p-value=0.039, Figure 2B), where believability ratings for graphic and symbolic PHWs seemed to increase while ratings of suffering PHWs declined in the fourth wave. In Australia, a significant wave by imagery type interaction was observed, with believability ratings increasing at a faster rate for graphic than for suffering PHWs (χ^2=8.91, p-value=0.012, Figure 2C).

Quit motivation

Main effects for survey waves indicated no changes in quit motivation ratings in Canada, Mexico, and Australia. For main effects of PHW imagery type, symbolic images in Canada were rated lower on quit motivation than suffering and graphic images. Graphic images were rated comparably to suffering images in Canada, but were rated higher in Australia, and lower in Mexico (Table 2). No statistically significant interaction between wave and imagery type was observed in any country.

Discussion about PHWs

Results for the main effects of survey wave showed no significant changes in discussions about PHWs in Canada (p-value=0.638), Australia (p-value=0.393), or Mexico (p-value=0.225). For the effects of imagery type, compared to suffering PHWs, graphic PHWs were more likely to be discussed in Canada, but less likely to be discussed in Australia and Mexico (Table 2). Canadian symbolic PHWs were less likely to be discussed than the graphic PHWs, but were no

different from the suffering PHWs (Table 2). Significant interactions between wave and imagery type were observed for Canada (χ^2=14.9, *p*-value=0.021) and Australia (χ^2=10.13, *p*-value=0.006). In Canada, discussion of graphic PHWs declined relative to suffering and symbolic PHWs (Figure 2D). By contrast, in Australia, over time, suffering PHWs were less likely to be discussed relative to graphic PHWs (Figure 2E).

DISCUSSION

This study found that a range of desirable responses to PHWs (i.e., noticing, negative affect, believability, quit motivation, and discussion about PHWs) were generally sustained over the 12- to 16-month study period, with no evidence of wear-out except for negative affect responses in Mexico. Our findings also indicate that smokers' responses to PHWs were influenced by the type of imagery used and, in some cases, by country. Compared to those with suffering imagery, PHWs with graphic imagery were only less noticeable in Canada, elicited greater negative affect and less believability in all countries, but differed in motivating smokers to quit and generating discussions in all countries.

Prior observational studies have found that smokers' responses to PHWs wear out over time;[8,23,24] however, this wear out may be due to reduced attention to the warnings. Our findings clearly show that when smokers are forced to view and evaluate PHWs, they do not lose their potency or basic recognition over the study period of more than 1 year, suggesting that it may be more meaningful to change the format and design of PHWs (e.g. background colors) in ways that re-elicit increased attention, rather than changing the propositional content or imagery. Indeed, this is consistent with Li et al who found no evidence of that two distinct sets of PHWs that rotate annually reduced wear-out in Australia, including in the year when the second set appeared for the first time.[8] However, the significant interaction between survey wave and

imagery type in Mexico showed different pattern with their PHWs became more believable in wave 3 and 4 with suffering imagery being rated higher than graphic imagery. The current study also provides some evidence that PHWs with suffering themed content are either equally or more initially attention-grabbing than other PHW imagery. This is consistent with research in other domains that show people's tendency to orient their attention toward facial stimuli over non-facial stimuli.[25,26] Additionally, our findings may, in part, reflect how PHW imagery can include both suffering and 'graphic' elements in addition to only facial portrayal of those who suffer from smoking related health issues. This is generally consistent with previous findings that PHWs featuring both graphic health effects and depictions of suffering are equally or more effective than graphic images alone.[15,27]

For ratings of negative affect, we found mixed results across countries with no evidence of wear-out in Canada, an increase of negative affect ratings in Australia, and a decrease of the ratings in Mexico. It is unclear what the mechanisms responsible for the country differences might be, but one possible reason for this might be due to the differences in image size across countries. Our findings also provide support for past experimental studies that have found graphic PHWs are superior to other types of PHW imagery in term of eliciting negative affect,[12,13,28] which also support our classification of imagery type based on the level of gruesome content and the extent to which they elicit negative reactions.[9,10] Across all countries, graphic PHWs yielded higher ratings on negative affect than suffering PHWs, while symbolic PHWs in Canada were rated as being the least emotionally evocative. This is consistent with previous experiment that showed PHWs with symbolic imagery produce relatively lower neural activation.[15]

We found no wear-out for the believability ratings of PHWs, which is generally consistent with previous research that showed the believability of health warnings is sustained over time.[29,30] Our findings also support prior experimental research[13,14] that has found symbolic PHWs are the least believable imagery type. However, we also found that suffering PHWs were rated as the most believable across three countries, which is inconsistent with previous research that showed graphic PHWs as the most believable.[13] Interestingly, the relatively greater believability of suffering imagery in Canada and Australia converged over time with other types of imagery, suggesting that smokers may need longer time to accept the messages in graphic or symbolic PHWs.

We found that the relative effects of PHW imagery type on quit motivation were different across the countries, with no differences between graphic and suffering PHWs in Canada, whereas graphic PHWs were superior to suffering PHWs in Australia, while the reverse was found in Mexico. These mixed findings across the countries may reflect country differences, including differences in the number of stimuli selected for the study, the textual and topical content of each image type and/or the characteristics of the studied sample. Future studies are needed to examine this issue in a systematic manner. Nevertheless, effects of different imagery types on quit motivation appears sustained over time in all three countries with some evidence that this effect gradually increased in Australia, the only country that has implemented plain packaging.

The ability of different PHW imagery types to stimulate discussion also appears different across countries. In Canada, graphic PHWs were superior to suffering and symbolic PHWs in stimulating discussion, but the effect was not sustained and declined to similar levels as for other imagery types over the study period. In Australia and Mexico, however, the pattern was in the

opposite direction, with suffering PHWs being superior to graphic PHWs for stimulating discussion. This effect remained steady in Mexico, but not in Australia where the superiority of suffering PHWs declined to the same levels as graphic PHWs over the study period. Again, it is unclear what the mechanisms responsible for the country differences might be. One possible reason for the divergent findings might be due to the combination of different features of the warnings (e.g., image size, color formatting, etc.), the relative novelty and the number of years since the change in image content across the countries.

Limitation

Our study has several limitations. Our main limitation is the differences in stimuli by country and within each category, and in some cases within country over time. Hence, interpretations around cross-country comparisons should be tempered by this regard. We aimed to assess the actual PHWs implemented in each country, but we could not assess them all due to the differences in the numbers and in the rotation of PHWs in each country. This resulted in an unbalanced number of stimuli across the imagery type and the countries. More formal tests of mediation may help determine whether the balance of imagery on warnings should be in favor of one type or another. With only a few examples of each class of warnings, our findings could be due to the quality of the textual content or other message features, not necessarily the way we have categorized the images. Consistent effects of the messages would have provided a stronger evidence for our categorization. Second, data for this study came from an online consumer panel that were gathered from no known sampling frame, which limited the ability to generalize the results to the broader population of smokers. However, the sample was designed to be comparable to population of smokers in each country except Mexico, where smokers with higher educational level are overrepresented due to differential Internet penetration. Lastly, with

moderate retention rates (about 50%), our study results could be affected by non-response and attrition biases although all the estimates were adjusted for survey participation frequency, sociodemographic and smoking-related variables.

Conclusion

Our study was the first to assess over-time reactions to specific types of PHW imagery under conditions of natural exposure. Using a recognition task paradigm, this study shows that when PHWs are attended to, they do not lose their potency over time suggesting that past findings of wear-outs may be due to less attention being paid to the PHWs over time. Future research can assess whether changing the design elements rather than just the propositional contents of PHWs may be a more effective way to maintain warning impact. Such research will be useful as over 100 countries have rotating pictorial warnings for which they have the opportunity to change warning content & design. Our study also shows that PHWs with suffering and graphic imagery appear to have different routes of impact and may work in complementary fashion in achieving the intended effects of PHWs.

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Contributors. DA contributed to devising methodological approach, analyzed the data and drafted the manuscript. H-HY and KS assisted with data analysis and interpretation of results. JFT conceptualized, designed the project, and obtained research funding. RB and DH contributed to the interpretation of findings. DA, H-HY, RB, DH, KS, JFT contributed to successive drafts, and approved the final manuscript.

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Figure 1. Study stimuli for each country, by imagery type.

Figure 2. Trends of noticing, believability, and discussion of PHWs.

Table 1. Characteristics of current smokers at each survey wave by country (in %)

	CANADA				AUSTRALIA			MEXICO			
	W1	W2	W3	W4	W2	W3	W4	W1	W2	W3	W4
N =	1,000	969	964	967	970	963	968	1,000	956	956	948
Age											
18-24	13.7	12.8	11.3	12.1	7.7	7.9	7.8	20.0	20.1	20.2	20.6
25-34	22.2	22.0	22.9	22.7	22.1	23.3	24.7	30.0	29.9	30.0	32.2
35-44	22.2	21.6	21.9	20.5	22.5	23.5	23.5	20.0	20.0	19.8	19.1
45-54	20.3	20.9	21.4	22.5	24.1	22.4	22.6	15.0	14.8	15.1	15.0
55-64	21.6	22.7	22.5	22.2	23.6	22.9	21.4	15.0	15.2	14.9	13.1
Sex											
Male	40.5	43.0	44.4	46.3	41.3	43.6	47.8	54.8	54.7	52.8	55.9
Female	59.5	57.0	55.6	53.7	58.7	56.4	52.2	45.2	45.3	47.2	44.1
Education											
High school or less	30.1	33.7	37.4	31.3	38.7	37.0	29.9	6.1	6.6	6.5	3.3
College or some university	43.8	46.5	47.1	42.9	42.1	43.2	41.9	47.7	55.7	61.3	44.6
Completed university or higher	26.1	19.8	15.5	25.8	19.3	19.8	28.2	46.2	37.7	32.2	52.1
Income											
Low	28.4	27.7	28.8	24.9	24.4	23.6	22.7	46.3	43.0	42.7	38.9
Middle	32.6	32.1	31.5	31.3	25.5	28.4	27.4	29.5	35.0	34.1	32.8
High	39.0	40.2	39.7	43.8	50.2	48.0	49.9	24.2	22.0	23.2	28.3
Smoking Intensity											
non-daily	22.0	15.9	16.5	18.3	12.3	12.8	13.2	51.2	52.8	49.3	50.5
daily, 10 cpd or less	23.7	28.8	25.1	27.8	23.1	24.3	25.4	33.7	30.3	34.3	33.1
daily, more than 10 cpd	54.3	55.3	58.4	53.9	64.6	62.9	61.4	15.1	16.8	16.4	16.4
Quit intentions in next 6-months											
Yes	47.3	43.5	41.8	43.02	40.1	39.7	41.5	40.6	47.5	46.6	46.6
No	52.7	56.5	58.2	56.98	59.9	60.3	58.5	59.4	52.5	53.4	53.4
Quit attempts in past 4-months											
Yes	41.7	40.0	37.2	38.2	34.0	34.0	35.5	48.0	53.2	55.0	52.7
No	58.3	60.0	62.8	61.8	66.0	66.0	64.5	52.0	46.8	45.0	47.3

Note: Country differences in sample characteristics at baseline wave were all significant ($p<0.01$ for quit intention and $p<0.001$ for others); cpd, cigarette per day.

Table 2. Final GEE model showing main effects of wave and image type, along with any significant interaction between wave and image type

Outcomes, Independent Variables	CANADA			AUSTRALIA			MEXICO		
	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*
Noticing PHW, OR (95% CI)									
Survey Wave			0.019			0.528			<0.001
wave 1	ref			ref			ref		
wave 2	1.08	(0.95, 1.23)	0.229	n/a			1.05	(0.88, 1.25)	0.620
wave 3	**1.26**	(1.09, 1.47)	0.002	1.12	(0.92, 1.37)	0.258	1.20	(1.00, 1.44)	0.056
wave 4	1.18	(1.00, 1.40)	0.055	1.08	(0.85, 1.38)	0.521	**1.81**	(1.48, 2.20)	<0.001
Image Type			<0.001			0.545			0.363
Suffering	ref			ref			ref		
Symbolic	**0.65**	(0.61, 0.69)	<0.001	n/a			n/a		
Graphic	**0.70**	(0.66, 0.74)	<0.001	0.98	(0.91, 1.05)	0.545	0.95	(0.86, 1.06)	0.363
Wave x Image interaction									0.027
wave 2 x symbolic	n/a			n/a			n/a		
wave 2 x graphic	n/a			n/a			0.92	(0.80, 1.05)	0.219
wave 3 x symbolic	n/a			n/a			n/a		
wave 3 x graphic	n/a			n/a			1.04	(0.90, 1.20)	0.624
wave 4 x symbolic	n/a			n/a			n/a		
wave 4 x graphic	n/a			n/a			**0.86**	(0.74, 0.99)	0.034
Negative Affects, β (95% CI)									
Survey Wave			0.629			0.027			0.044
wave 1	ref			n/a			ref		
wave 2	0.06	(-0.08, 0.20)	0.384	ref			0.00	(-0.14, 0.15)	0.950
wave 3	0.08	(-0.11, 0.28)	0.402	**0.22**	(0.03, 0.40)	0.021	-0.06	(-0.24, 0.13)	0.550
wave 4	0.03	(-0.23, 0.28)	0.837	**0.36**	(0.09, 0.63)	0.009	**-0.25**	(-0.47, -0.02)	0.031
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.85**	(-0.90, -0.80)	<0.001	n/a			n/a		
Graphic	**0.49**	(0.45, 0.52)	<0.001	**0.22**	(0.17, 0.27)	<0.001	**0.33**	(0.29, 0.35)	<0.001
Believability, β (95% CI)									
Survey Wave			0.812			0.162			0.247
wave 1	ref			n/a			ref		
wave 2	0.01	(-0.14, 0.17)	0.868	ref			-0.10	(-0.24, 0.04)	0.177
wave 3	0.04	(-0.18, 0.26)	0.722	0.15	(-0.06, 0.36)	0.155	-0.09	(-0.25, 0.08)	0.301
wave 4	-0.04	(-0.31, 0.24)	0.787	0.29	(-0.01, 0.56)	0.057	-0.18	(-0.38, 0.01)	0.064
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.65**	(-0.74, -0.56)	<0.001	n/a			n/a		
Graphic	**-0.43**	(-0.51, -0.35)	<0.001	**-0.22**	(-0.30, -0.14)	<0.001	**-0.24**	(-0.28, -0.21)	<0.001

Outcomes, Independent Variables	CANADA			AUSTRALIA			MEXICO		
	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*
Wave x Image interaction			0.039			0.012			
wave 2 x symbolic	0.00	(-0.12, 0.12)	0.998	n/a			n/a		
wave 2 x graphic	0.02	(-0.08, 0.13)	0.677	n/a			n/a		
wave 3 x symbolic	0.07	(-0.05, 0.19)	0.254	n/a			n/a		
wave 3 x graphic	0.03	(-0.08, 0.13)	0.645	0.09	(-0.01, 0.19)	0.092	n/a		
wave 4 x symbolic	**0.15**	(0.03, 0.27)	0.012	n/a			n/a		
wave 4 x graphic	**0.14**	(0.03, 0.24)	0.009	**0.16**	(0.05, 0.26)	0.003	n/a		
Quit Motivation, β (95% CI)									
Survey Wave			0.646			0.062			0.263
wave 1	ref			n/a			ref		
wave 2	0.04	(-0.12, 0.20)	0.630	ref			0.04	(-0.12, 0.20)	0.624
wave 3	0.12	(-0.09, 0.34)	0.264	0.21	(0.00, 0.43)	0.052	-0.03	(-0.24, 0.18)	0.769
wave 4	0.08	(-0.19, 0.34)	0.577	**0.34**	(0.05, 0.63)	0.021	-0.17	(-0.42, 0.09)	0.195
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.96**	(-1.01, -0.90)	<0.001	n/a			n/a		
Graphic	-0.01	(-0.05, 0.03)	0.478	**0.18**	(0.12, 0.23)	<0.001	**-0.07**	(-0.10, -0.03)	<0.001
Discussion about PHWs, OR (95% CI)									
Survey Wave			0.638			0.393			0.225
wave 1	ref			ref			ref		
wave 2	0.85	(0.65, 1.11)	0.224	n/a			1.12	(0.95, 1.32)	0.172
wave 3	0.89	(0.68, 1.18)	0.430	0.92	(0.75, 1.13)	0.441	0.97	(0.82, 1.17)	0.731
wave 4	0.96	(0.73, 1.27)	0.792	0.84	(0.65, 1.08)	0.172	1.06	(0.89, 1.27)	0.518
Image Type			<0.001			<0.001			0.004
Suffering	ref			ref			ref		
Symbolic	0.83	(0.67, 1.01)	0.063	n/a			n/a		
Graphic	**1.41**	(1.20, 1.65)	<0.001	**0.53**	(0.46, 0.61)	<0.001	**0.94**	(0.90, 0.98)	0.004
Wave x Image interaction			0.021			0.006			
wave 2 x symbolic	0.98	(0.75, 1.29)	0.888	n/a			n/a		
wave 2 x graphic	0.98	(0.79, 1.22)	0.847	n/a			n/a		
wave 3 x symbolic	0.97	(0.72, 1.30)	0.842	n/a			n/a		
wave 3 x graphic	0.87	(0.69, 1.09)	0.232	1.05	(0.87, 1.26)	0.634	n/a		
wave 4 x symbolic	1.04	(0.78, 1.38)	0.795	n/a			n/a		
wave 4 x graphic	**0.70**	(0.57, 0.88)	0.002	**1.33**	(1.10, 1.61)	0.004	n/a		

Note: est, estimate; β, regression coefficient; OR, odds ratio; CI, confidence interval; n/a, not applicable;
Interaction and stratification models were adjusted. Adjustment variables include: age, sex, educational level, income level, quit intention in the next 6 months, quit attempt, Heaviness of Smoking Index, daily smoking status, time in sample, and race (Canada only).

Country	PHW Imagery Type		
	Suffering	Symbolic	Graphic
Canada			
Australia *		*Not included*	
Mexico		*Not included*	

Notes:
* Included only PHWs from the first set of 7 new health warnings on standardized packaging implemented in December 2012 in Australia.

All images are in the public domain, as they are images that are printed on cigarette packs that you can purchase in each country. For that reason, they can be used for research purposes, and they can be published in scientific manuscripts without permission

Figure 1. Study stimuli for each country, by imagery type.

215x279mm (300 x 300 DPI)

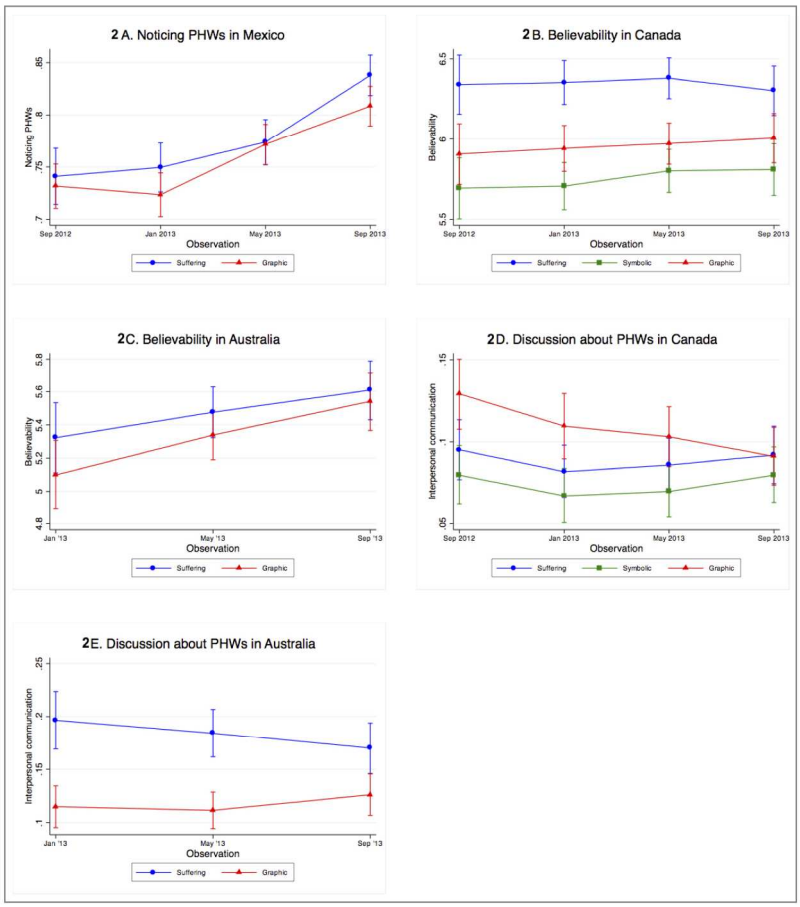

Figure 2. Trends of noticing, believability, and discussion of PHWs.

209x296mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6, 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8, 9
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9, 10
		(*b*) Describe any methods used to examine subgroups and interactions	9, 10
		(*c*) Explain how missing data were addressed	9, 10
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	6

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10, 22
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	22
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	10-12
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	-
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12
		(*b*) Report category boundaries when continuous variables were categorized	7, 10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	16-17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 1. Percentage or Mean (SE) level for each outcome by survey wave and by imagery type

Outcomes, Survey waves	**CANADA**				**AUSTRALIA**			**MEXICO**		
		Imagery Type				Imagery Type			Imagery Type	
	Wave	*Graphic*	*Suffering*	*Symbolic*	Wave	*Graphic*	*Suffering*	Wave	*Graphic*	*Suffering*
Noticing PHWs, %										
Sep 2012	55.82	59.40	66.57	56.30	n/a	n/a	n/a	72.07	71.73	73.07
Jan 2013	62.12	64.25	72.99	63.40	82.16	81.78	82.91	74.39	73.37	76.07
May 2013	64.14	66.76	74.15	64.86	80.67	80.82	80.36	76.97	76.81	77.24
Sep 2013	62.74	64.85	71.51	63.79	79.23	79.32	79.07	81.11	79.95	83.03
Negative Affects, Mean (SE)										
Sep 2012	5.37 (0.03)	5.74 (0.04)	5.25 (0.04)	4.35 (0.06)	n/a	n/a	n/a	6.09 (0.03)	6.19 (0.03)	5.82 (0.05)
Jan 2013	5.36 (0.03)	5.73 (0.05)	5.21 (0.05)	4.39 (0.06)	4.99 (0.03)	5.04 (0.04)	4.89 (0.06)	6.06 (0.03)	6.19 (0.03)	5.86 (0.04)
May 2013	5.32 (0.03)	5.68 (0.05)	5.17 (0.05)	4.36 (0.06)	4.93 (0.03)	5.01 (0.04)	4.76 (0.06)	5.96 (0.03)	6.07 (0.03)	5.77 (0.04)
Sep 2013	5.27 (0.03)	5.61 (0.05)	5.16 (0.04)	4.36 (0.06)	4.98 (0.03)	5.07 (0.04)	4.81 (0.06)	5.91 (0.03)	6.03 (0.03)	5.71 (0.04)
Believability, Mean (SE)										
Sep 2012	6.07 (0.03)	5.99 (0.05)	6.42 (0.04)	5.77 (0.06)	n/a	n/a	n/a	6.80 (0.03)	6.75 (0.03)	6.97 (0.05)
Jan 2013	6.01 (0.03)	5.93 (0.05)	6.34 (0.04)	5.70 (0.06)	5.35 (0.03)	5.28 (0.04)	5.50 (0.06)	6.74 (0.03)	6.64 (0.03)	6.90 (0.04)
May 2013	5.98 (0.03)	5.89 (0.05)	6.28 (0.04)	5.74 (0.06)	5.39 (0.03)	5.35 (0.04)	5.47 (0.06)	6.68 (0.02)	6.58 (0.03)	6.86 (0.04)
Sep 2013	5.97 (0.03)	5.94 (0.05)	6.22 (0.04)	5.73 (0.06)	5.36 (0.04)	5.35 (0.04)	5.40 (0.06)	6.63 (0.02)	6.54 (0.03)	6.78 (0.04)
Quit Motivation, Mean (SE)										
Sep 2012	5.07 (0.03)	5.21 (0.05)	5.27 (0.05)	4.22 (0.06)	n/a	n/a	n/a	6.07 (0.03)	6.07 (0.03)	6.09 (0.06)
Jan 2013	5.05 (0.03)	5.22 (0.05)	5.19 (0.05)	4.30 (0.06)	4.46 (0.04)	4.51 (0.05)	4.37 (0.07)	6.16 (0.03)	6.13 (0.04)	6.22 (0.05)
May 2013	5.04 (0.03)	5.20 (0.05)	5.17 (0.05)	4.29 (0.06)	4.47 (0.04)	4.55 (0.04)	4.32 (0.07)	6.03 (0.03)	6.01 (0.04)	6.08 (0.05)
Sep 2013	4.99 (0.03)	5.13 (0.05)	5.16 (0.05)	4.22 (0.06)	4.58 (0.04)	4.63 (0.05)	4.46 (0.07)	5.97 (0.03)	5.94 (0.04)	6.01 (0.05)

Outcomes, Survey waves	**CANADA**				**AUSTRALIA**			**MEXICO**		
		Imagery Type				Imagery Type			Imagery Type	
	Wave	*Graphic*	*Suffering*	*Symbolic*	Wave	*Graphic*	*Suffering*	Wave	*Graphic*	*Suffering*
Discussion of PHWs, %										
Sep 2012	14.75	17.86	13.07	12.18	n/a	n/a	n/a	31.65	31.00	33.56
Jan 2013	10.50	12.89	9.32	8.14	18.31	14.90	24.98	32.32	31.52	33.61
May 2013	9.96	11.37	9.50	8.06	13.14	10.85	17.73	30.56	30.16	31.22
Sep 2013	10.32	10.49	10.00	9.24	13.91	12.47	16.81	31.66	31.36	32.14

BMJ Open

Which type of tobacco product warning imagery is more effective and sustainable over time? A longitudinal assessment of smokers in Canada, Australia, and Mexico

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Title: Which type of tobacco product warning imagery is more effective and sustainable over time? A longitudinal assessment of smokers in Canada, Australia, and Mexico

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Abstract (words: 261 // 300 max)

Objective. This study examined smokers' responses to pictorial health warnings (PHWs) with different types of imagery under natural exposure conditions.

Methods. Adult smokers from online panels in Canada (n=2,357), Australia (n=1,671) and Mexico (n=2,537) were surveyed every four months from 2012 to 2013. Participants were shown PHWs on packs in their respective countries and asked about: 1) Noticing PHWs; 2) Negative affects toward PHWs; 3) Believability of PHWs; 4) PHW-stimulated discussions; and 5) Quit motivation due to PHWs. Country-specific generalized estimating equation models regressed these outcomes on time (i.e., survey wave), PHW imagery type (i.e., symbolic representations of risk; suffering from smoking; graphic depictions of bodily harm), and interactions between them.

Results. In all countries, PHW responses did not significantly change over time, except for increased noticing PHWs in Canada and Mexico, increased negative affect in Australia, and decreased negative affect in Mexico. For all outcomes, symbolic PHWs were rated lower than suffering and graphic PHWs in Canada (the only country with symbolic PHWs). Graphic PHWs were rated higher than suffering PHWs for negative affect (all countries), discussions (Canada), and quit motivation (Australia). Suffering PHWs were rated higher than graphic PHWs for noticing PHWs (Canada), believability (all countries), discussions (Australia & Mexico), and quit motivation (Mexico). Changes in noticing, believability and discussions varied somewhat by imagery type across countries.

Conclusions. The different PHW imagery appears to have different pathways of influence on adult smokers. Reactions to specific PHWs are similar over 1-2 years, suggesting that wear-out of PHW effects is due to decreased attention rather than the diminishing effectiveness of content.

Keywords: policy; tobacco control; communication; graphic warning

Strengths and limitations of this study

- This study used a longitudinal assessment of smokers' responses under naturalistic and repeated exposure to PHWs to understand how different types of PHW imagery works over time.
- This study used measures of affective, cognitive and motivational responses of smokers exposed to PHWs with different types of imagery to understand the mechanisms for changes in responses over time.
- While other population-based studies used recalled impact of PHWs, this study presented specific PHWs that were on packs at the time of the survey to the participants.
- The differences in stimuli by country and within each category limit the interpretations around cross-country comparisons.
- Data for this study came from an online consumer panel which may limit the generalizability of the results to the broader population of smokers.

INTRODUCTION

The World Health Organization's Framework Convention on Tobacco Control recommends that countries implement multiple, prominent pictorial health warnings (PHWs) to communicate about tobacco-related diseases.[1] Over 70 countries have implemented PHWs using a great variety of messages and imagery.[2] Previous experimental studies have shown that compared to the text-only warnings, PHWs are more salient,[3] believable,[4] elicit stronger negative affect, and more likely to motivate cessation.[5–7] Although observational studies indicate that all forms of PHW regimens lose their effectiveness over time,[8] the mechanisms for wear-out are uncertain, as are the conditions under which wear-out might be reversed. In particular, it is not clear whether wear-out effects are because smokers become inured to PHW messages or are just less likely to attend to them. Further, of the wide variety of imagery used in PHWs, no studies of which we are aware have examined whether some types of imagery work best over time.

Based on the fear appeal theory, the effects of messages vary with the level of gruesome content or with the level of negative reaction elicited from the messages.[9,10] Thus, the imagery used in PHWs can be classified according to the level of gruesome content (i.e., from the most frightening to the least frightening), and negative affect such as disgust can explain audience reaction to PHWs.[11] Some experimental studies have examined responses to different types of pictorial imagery on PHWs,[12–16] generally classifying PHW imagery into three main categories: 1) Graphic: Vivid depiction of negative health consequences or physical effects of smoking; 2) Suffering: Portrayal of personal experiences living with smoking-related diseases, including negative impacts on quality of life; and 3) Symbolic: Abstract or metaphorical representations of the negative effects of smoking. Previous experimental studies have consistently indicated that PHWs with graphic imagery elicit relatively stronger attentional, cognitive and behavioral

responses.[12,13,17,18] Furthermore, data from functional magnetic resonance imaging found that the levels of activation of different neural regions involved in image interpretation and emotion varied in a manner consistent with self-reported ratings of different PHWs imagery types.[15] Nevertheless, prior evidence on the superiority of certain types of images mainly came from pre-market experimental studies, and there is very little research on the validity of pre-market experiments for determining pictorial warning content that is most effective after policy implementation. Longitudinal studies of smokers' responses under naturalistic, repeated exposure to PHWs are needed to understand how different imagery works over time. Our study aimed to fill that gap by embedding specific warning rating methods used in experimental research into a longitudinal study design of consumer responses post-implementation of new warnings.

Study Context

Canada pioneered PHWs, implementing its first round in June 2001 with a set of 16 PHWs that covered 50% of the front and back of cigarette packs. In 2012, a new set of 16 PHWs were implemented, covering 75% of the front and back of packs. In March 2006, Australia implemented its first PHWs, which covered 30% of the front and 90% of the back of cigarette packs. In December 2012, Australia introduced a new set of PHWs, rotating seven new PHWs each year, and pioneered standardized packaging that required all tobacco products be sold in dull, brown packages, with the same font and without company logos. Mexico first implemented PHWs in September 2010, requiring PHWs that covered 30% of the front and a text-only warning covering 100% of the back. Since 2012, four new PHWs were implemented every six months.

Using longitudinal data collected from adult smokers in Canada, Australia and Mexico, this study sought to examine: a) the affective, cognitive and motivational responses of smokers exposed to PHWs with different types of imagery (i.e., graphic, suffering, and symbolic); b) whether these responses changed over time; and c) whether the changes in responses over time depended on types of imagery. Other population-based studies have involved recalled impact of PHWs, in general; by contrast, this study presented specific PHWs that were on packs at the time of the survey, and queried smokers' ratings of these at the time of survey. This approach helps separate out potential habituation to the PHW message itself from the effects of attention toward PHWs.

METHOD

Patient and Public Involvement

This study did not involve patients nor the public as participants. Our study participants came from a consumer panel used for market research, all contact with participants was managed by a private company (GMI Lightspeed), and datasets we received did not include any information that would allow us to identify participants.

Sample

Data for this study came from an online consumer panel of adult smokers followed up every four months in Canada, Australia and Mexico who were 18 to 64 years old, had smoked 100 or more cigarettes in their lifetime, and had smoked at least once in the previous month. Sample size in each country was approximately 1,000 at each wave, with replenishment sampling used to maintain sample size across waves and to reduce the attrition bias. For this study, the analytic sample included only current smokers at each wave (see Table 1) as ex-smokers were less likely to be exposed to PHWs. Additionally, to be comparable, only data from

post-implementation period in each country were included in the analysis (i.e., in Canada and Mexico: 4 survey waves from September 2012 to September 2013; in Australia: 3 survey waves from January 2013 to September 2013). Reporting of this study adhered to the STROBE guidelines (Appendix 1).

Materials

PHWs used as stimuli varied across countries depending on the actual PHWs implemented in each country. To reduce participant burden, participants were presented with only a subset of PHWs that appeared on cigarette packs in their respective country during the study period. Each participant was presented and asked to rate each of the PHWs in the subset. PHWs were selected to maximize the number with shared topical foci across countries. Of the 16 PHWs on the market in Canada, we selected eight for our study (three suffering; three graphic; two symbolic). We also selected eight PHWs for Australia and Mexico; however, two of the PHWs for Australia were implemented after the study period, resulting in six PHWs analyzed for this study (i.e., two PHWs with suffering imagery and four PHWs with graphic imagery). Four new PHWs were introduced every six months in Mexico, where regulations do not require that packs with PHWs from prior rounds; Surveys in Mexico integrated some new PHWs while deleting others over time, resulting in 10 stimuli for this study (i.e., four PHWs with suffering imagery and six PHWs with graphic imagery; see Figure 1 for all stimuli used in this study by country and imagery type). PHW stimuli were presented in random order to account for ordering effects, and participants were asked a set of questions after viewing each of the stimuli.

Measures

Main outcomes

Participants were asked about five topical domains for each PHW assessing affective, cognitive and motivational responses that have been shown to be important mediators for warning label impact.[7,19,20] Noticing PHW was assessed using one item (i.e., "In the last month, how often have you seen this warning on the cigarette packs that you buy?"), with responses ranging from 1 (never) to 5 (very often). Due to a skewed distribution, responses were dichotomized with 0 for those who answered never, and 1 for those who answered once to very often. Negative affect was measured using three items (i.e., "How much does this warning make you feel afraid?"; "How disgusting is this warning label?"; and "How much does this warning make you feel worried about the health risks of smoking?") to which participants indicated agreement using a nine-point response scale with "not at all" and "extremely" at scale endpoints. Responses of these items were averaged to form a scale (range of Cronbach's alpha across PHWs in Canada=0.86–0.91; Australia=0.86–0.93; Mexico=0.78–0.85). Message believability was measured using a single item (i.e., "How believable is this warning?"), and so was quit motivation (i.e., "How much does this warning make you want to quit smoking?"), with both using a 9-point response scale, as above. Lastly, discussion about warning in the past month was assessed (i.e., "In the last month, have you talked with anyone about this warning?"), with a "yes" or "no" answer.

Independent variables

Each PHW was classified by type of imagery used (i.e., graphic, suffering, and, in Canada only, symbolic), using dummy coding with suffering imagery as the reference group. We created dummy variables for survey waves ranging from wave 1 to wave 4 for Canada and Mexico (with wave 1 as the reference), and from wave 2 to wave 4 for Australia (with wave 2 as the reference).

Adjustment variables

Adjustment variables included socio-demographic and smoking relevant variables. Socio-demographic variables included age group (18-24; 25-34; 35-44; 45-54; 55-64), gender, educational level (high school or less; some college or university; and completed university or higher), annual household income (Australia and Canada: $29,999 or less, $30,000-$59,999, and $60,000 or more; Mexico, monthly income, in pesos: $5,000 or less, $5,001-$10,000, and $10,001 or more), and race (for Canada only, white and non-white). Smoking-relevant variables included nicotine dependence, using the Heaviness of Smoking Index (HSI) that combined the number of cigarettes smoked per day and time to first cigarette of the day.[21,22] Intention to quit was measured by asking about plans to quit smoking (within the next month; within the next 6 months; sometime in the future, beyond 6 months; not planning to quit; don't know), with responses dichotomized to reflect intentions to quit smoking within the next month or six months versus other responses. Recent quit attempts were measured by asking if participants have made a quit attempt in the prior 4 months. Additionally, to control for possible instrumentation effects due to prior survey participation, we also assessed and created dummy variables for the number of prior surveys completed by participants, using their first participation as the reference.

Data analysis

All analyses were conducted using Stata version 12, and were conducted separately by country due to the different PHWs assessed across countries. Each PHW was treated as a separate observation. To adjust for the correlated nature of the data and to maximize the number of cases available for analysis, generalized estimating equation (GEE) models with an exchangeable correlation matrix were used to compute parameter estimates. Separate bivariate and adjusted GEE models were estimated to assess the main effects of survey wave and PHW

imagery type on each of the outcomes. To assess linearity of trends over time, survey wave was treated as a continuous variable while controlling for adjustment variables; then a quadratic term (wave squared) was added to test for any nonlinearity in trends. For the final models, survey wave was treated as a categorical variable, and interaction terms between imagery type and survey wave were added into the models to test whether the patterns of change over time in outcomes of interest varied by PHW imagery type. Adjusted models included socio-demographics, smoking-related variables and time-in-sample. We also conducted some sensitivity analyses: First, for all models, we included variables to control media exposure that may coincided with PHW implementation that could also affect our study outcomes. The results were the same in terms of direction, magnitude and statistical significance. Second, we conducted sensitivity analyses with models regressing noticing PHWs as a continuous variable and as a dichotomous variable with different cut point, and regressing negative affect with the three original variables. Results were mostly consistent in terms of direction, magnitude, and statistical significance.

RESULTS

Sample Characteristics

Sample characteristics by country and survey wave are shown in Table 1. In baseline samples, over half of participants were women in Canada and Australia, while the reverse was true in Mexico. Most Mexican participants had some college or higher level of education, while about one third of Canadian and Australian participants had high school or less education. Compared to Canadian and Australian participants, Mexican participants were also younger, and had more non-daily smokers. The proportion of smokers who reported having attempted to quit was lower among Australian participants than those in Canada and Mexico.

Changes of PHW Responses Over Time

Noticing PHWs

We dichotomized responses to 0 for those who answered never versus 1 for those who answered otherwise. Most respondents saw the warnings in the last month (55%-64% in Canada, 79%-82% in Australia, and 72%-81% in Mexico; see Appendix 2). In the adjusted model for Australia, no change in noticing PHWs over the study period was observed (p-value=0.528), with no statistically significant interaction to indicate a different pattern by imagery type. By contrast, noticing PHWs increased over the study period in both Canada and Mexico. In Canada, this increase was in a linear fashion (p-value=0.019) whereas in Mexico the trend was non-linear (quadratic trend p-value=0.004, Figure 2A). Main effects of imagery type on noticing PHWs also showed differences across countries. In Canada, symbolic images were less likely to be noticed than the suffering images and the graphic images (Table 2). Compared to the suffering images, graphic images were less likely to be noticed in Canada, but not in Australia or Mexico where no difference was observed (Table 2). A significant interaction between wave and imagery type was observed in Mexico suggesting the differences between PHWs with graphic and suffering images were significantly greater in the fourth waves (χ^2=14.93, p-value=0.027, Figure 2A).

Negative affect

Ratings of negative affect elicited by PHWs showed different patterns of results across the three countries (Table 2). For main effects of survey wave, negative affective responses did not change in Canada, increased in Australia (p-value=0.027), and declined in Mexico (p-value=0.044). No differences in these trends were found by imagery type. Graphic PHWs were rated higher than suffering PHWs on negative affect in Canada, Australia, and Mexico. Canadian symbolic PHWs were rated lower on negative affect than suffering and graphic PHWs (Table 2).

Believability

Adjusted models indicated no significant change in believability of PHWs over time in Canada (*p*-value=0.812), Australia (*p*-value=0.162), and Mexico (*p*-value=0.247). Compared to the suffering images, graphic images were rated lower on believability in Canada, Australia, and Mexico (Table 2). Also, in Canada, symbolic images were rated lower on believability than suffering and graphic images. A significant wave by imagery type interaction was observed in Canada (χ^2=13.28, *p*-value=0.039, Figure 2B), where believability ratings for graphic and symbolic PHWs seemed to increase while ratings of suffering PHWs declined in the fourth wave. In Australia, a significant wave by imagery type interaction was observed, with believability ratings increasing at a faster rate for graphic than for suffering PHWs (χ^2=8.91, *p*-value=0.012, Figure 2C).

Quit motivation

Main effects for survey waves indicated no changes in quit motivation ratings in Canada, Mexico, and Australia. For main effects of PHW imagery type, symbolic images in Canada were rated lower on quit motivation than suffering and graphic images. Graphic images were rated comparably to suffering images in Canada, but were rated higher in Australia, and lower in Mexico (Table 2). No statistically significant interaction between wave and imagery type was observed in any country.

Discussion about PHWs

Results for the main effects of survey wave showed no significant changes in discussions about PHWs in Canada (*p*-value=0.638), Australia (*p*-value=0.393), or Mexico (*p*-value=0.225). For the effects of imagery type, compared to suffering PHWs, graphic PHWs were more likely to be discussed in Canada, but less likely to be discussed in Australia and Mexico (Table 2). Canadian symbolic PHWs were less likely to be discussed than the graphic PHWs, but were no

different from the suffering PHWs (Table 2). Significant interactions between wave and imagery type were observed for Canada (χ^2=14.9, *p*-value=0.021) and Australia (χ^2=10.13, *p*-value=0.006). In Canada, discussion of graphic PHWs declined relative to suffering and symbolic PHWs (Figure 2D). By contrast, in Australia, over time, suffering PHWs were less likely to be discussed relative to graphic PHWs (Figure 2E).

DISCUSSION

This study found that a range of desirable responses to PHWs (i.e., noticing, negative affect, believability, quit motivation, and discussion about PHWs) were generally sustained over the 12- to 16-month study period, with no evidence of wear-out except for negative affect responses in Mexico. Our findings also indicate that smokers' responses to PHWs were influenced by the type of imagery used and, in some cases, by country. Compared to those with suffering imagery, PHWs with graphic imagery were only less noticeable in Canada, elicited greater negative affect and less believability in all countries, but differed in motivating smokers to quit and generating discussions in all countries.

Prior observational studies have found that smokers' responses to PHWs wear out over time;[8,23,24] however, this wear out may be due to reduced attention to the warnings. Our findings clearly show that when smokers are forced to view and evaluate PHWs, they do not lose their potency or basic recognition over the study period of more than 1 year, suggesting that it may be more meaningful to change the format and design of PHWs (e.g. background colors) in ways that re-elicit increased attention, rather than changing the propositional content or imagery. Indeed, this is consistent with Li et al who found no evidence of that two distinct sets of PHWs that rotate annually reduced wear-out in Australia, including in the year when the second set appeared for the first time.[8] However, the significant interaction between survey wave and

imagery type in Mexico showed different pattern with their PHWs became more believable in wave 3 and 4 with suffering imagery being rated higher than graphic imagery. The current study also provides some evidence that PHWs with suffering themed content are either equally or more initially attention-grabbing than other PHW imagery. This is consistent with research in other domains that show people's tendency to orient their attention toward facial stimuli over non-facial stimuli.[25,26] Additionally, our findings may, in part, reflect how PHW imagery can include both suffering and 'graphic' elements in addition to only facial portrayal of those who suffer from smoking related health issues. This is generally consistent with previous findings that PHWs featuring both graphic health effects and depictions of suffering are equally or more effective than graphic images alone.[15,27]

For ratings of negative affect, we found mixed results across countries with no evidence of wear-out in Canada, an increase of negative affect ratings in Australia, and a decrease of the ratings in Mexico. It is unclear what the mechanisms responsible for the country differences might be, but one possible reason for this might be due to the differences in image size across countries. Our findings also provide support for past experimental studies that have found graphic PHWs are superior to other types of PHW imagery in term of eliciting negative affect,[12,13,28] which also support our classification of imagery type based on the level of gruesome content and the extent to which they elicit negative reactions.[9,10] Across all countries, graphic PHWs yielded higher ratings on negative affect than suffering PHWs, while symbolic PHWs in Canada were rated as being the least emotionally evocative. This is consistent with previous experiment that showed PHWs with symbolic imagery produce relatively lower neural activation.[15]

We found no wear-out for the believability ratings of PHWs, which is generally consistent with previous research that showed the believability of health warnings is sustained over time.[29,30] Our findings also support prior experimental research[13,14] that has found symbolic PHWs are the least believable imagery type. However, we also found that suffering PHWs were rated as the most believable across three countries, which is inconsistent with previous research that showed graphic PHWs as the most believable.[13] Interestingly, the relatively greater believability of suffering imagery in Canada and Australia converged over time with other types of imagery, suggesting that smokers may need longer time to accept the messages in graphic or symbolic PHWs.

We found that the relative effects of PHW imagery type on quit motivation were different across the countries, with no differences between graphic and suffering PHWs in Canada, whereas graphic PHWs were superior to suffering PHWs in Australia, while the reverse was found in Mexico. These mixed findings across the countries may reflect country differences, including differences in the number of stimuli selected for the study, the textual and topical content of each image type and/or the characteristics of the studied sample. Future studies are needed to examine this issue in a systematic manner. Nevertheless, effects of different imagery types on quit motivation appears sustained over time in all three countries with some evidence that this effect gradually increased in Australia, the only country that has implemented plain packaging.

The ability of different PHW imagery types to stimulate discussion also appears different across countries. In Canada, graphic PHWs were superior to suffering and symbolic PHWs in stimulating discussion, but the effect was not sustained and declined to similar levels as for other imagery types over the study period. In Australia and Mexico, however, the pattern was in the

opposite direction, with suffering PHWs being superior to graphic PHWs for stimulating discussion. This effect remained steady in Mexico, but not in Australia where the superiority of suffering PHWs declined to the same levels as graphic PHWs over the study period. Again, it is unclear what the mechanisms responsible for the country differences might be. One possible reason for the divergent findings might be due to the combination of different features of the warnings (e.g., image size, color formatting, etc.), the relative novelty and the number of years since the change in image content across the countries.

Limitation

Our study has several limitations. Our main limitation is the differences in stimuli by country and within each category, and in some cases within country over time. Hence, interpretations around cross-country comparisons should be tempered by this regard. We aimed to assess the actual PHWs implemented in each country, but we could not assess them all due to the differences in the numbers and in the rotation of PHWs in each country. This resulted in an unbalanced number of stimuli across the imagery type and the countries. More formal tests of mediation may help determine whether the balance of imagery on warnings should be in favor of one type or another. With only a few examples of each class of warnings, our findings could be due to the quality of the textual content or other message features, not necessarily the way we have categorized the images. Consistent effects of the messages would have provided a stronger evidence for our categorization. Second, data for this study came from an online consumer panel that were gathered from no known sampling frame, which limited the ability to generalize the results to the broader population of smokers. However, the sample was designed to be comparable to population of smokers in each country except Mexico, where smokers with higher educational level are overrepresented due to differential Internet penetration. Lastly, with

moderate retention rates (about 50%), our study results could be affected by non-response and attrition biases although all the estimates were adjusted for survey participation frequency, sociodemographic and smoking-related variables.

Conclusion

Our study was the first to assess over-time reactions to specific types of PHW imagery under conditions of natural exposure. Using a recognition task paradigm, this study shows that when PHWs are attended to, they do not lose their potency over time suggesting that past findings of wear-outs may be due to less attention being paid to the PHWs over time. Future research can assess whether changing the design elements rather than just the propositional contents of PHWs may be a more effective way to maintain warning impact. Such research will be useful as over 100 countries have rotating pictorial warnings for which they have the opportunity to change warning content & design. Our study also shows that PHWs with suffering and graphic imagery appear to have different routes of impact and may work in complementary fashion in achieving the intended effects of PHWs.

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Figure 1. Study stimuli for each country, by imagery type.

Figure 2. Trends of noticing, believability, and discussion of PHWs.

Table 1. Characteristics of current smokers at each survey wave by country (in %)

	CANADA				AUSTRALIA			MEXICO			
	W1	W2	W3	W4	W2	W3	W4	W1	W2	W3	W4
N =	1,000	969	964	967	970	963	968	1,000	956	956	948
Age											
18-24	13.7	12.8	11.3	12.1	7.7	7.9	7.8	20.0	20.1	20.2	20.6
25-34	22.2	22.0	22.9	22.7	22.1	23.3	24.7	30.0	29.9	30.0	32.2
35-44	22.2	21.6	21.9	20.5	22.5	23.5	23.5	20.0	20.0	19.8	19.1
45-54	20.3	20.9	21.4	22.5	24.1	22.4	22.6	15.0	14.8	15.1	15.0
55-64	21.6	22.7	22.5	22.2	23.6	22.9	21.4	15.0	15.2	14.9	13.1
Sex											
Male	40.5	43.0	44.4	46.3	41.3	43.6	47.8	54.8	54.7	52.8	55.9
Female	59.5	57.0	55.6	53.7	58.7	56.4	52.2	45.2	45.3	47.2	44.1
Education											
High school or less	30.1	33.7	37.4	31.3	38.7	37.0	29.9	6.1	6.6	6.5	3.3
College or some university	43.8	46.5	47.1	42.9	42.1	43.2	41.9	47.7	55.7	61.3	44.6
Completed university or higher	26.1	19.8	15.5	25.8	19.3	19.8	28.2	46.2	37.7	32.2	52.1
Income											
Low	28.4	27.7	28.8	24.9	24.4	23.6	22.7	46.3	43.0	42.7	38.9
Middle	32.6	32.1	31.5	31.3	25.5	28.4	27.4	29.5	35.0	34.1	32.8
High	39.0	40.2	39.7	43.8	50.2	48.0	49.9	24.2	22.0	23.2	28.3
Smoking Intensity											
non-daily	22.0	15.9	16.5	18.3	12.3	12.8	13.2	51.2	52.8	49.3	50.5
daily, 10 cpd or less	23.7	28.8	25.1	27.8	23.1	24.3	25.4	33.7	30.3	34.3	33.1
daily, more than 10 cpd	54.3	55.3	58.4	53.9	64.6	62.9	61.4	15.1	16.8	16.4	16.4
Quit intentions in next 6-months											
Yes	47.3	43.5	41.8	43.02	40.1	39.7	41.5	40.6	47.5	46.6	46.6
No	52.7	56.5	58.2	56.98	59.9	60.3	58.5	59.4	52.5	53.4	53.4
Quit attempts in past 4-months											
Yes	41.7	40.0	37.2	38.2	34.0	34.0	35.5	48.0	53.2	55.0	52.7
No	58.3	60.0	62.8	61.8	66.0	66.0	64.5	52.0	46.8	45.0	47.3

Note: Country differences in sample characteristics at baseline wave were all significant ($p<0.01$ for quit intention and $p<0.001$ for others); cpd, cigarette per day.

Table 2. Final GEE model showing main effects of wave and image type, along with any significant interaction between wave and image type

Outcomes, Independent Variables	CANADA			AUSTRALIA			MEXICO		
	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*
Noticing PHW, OR (95% CI)									
Survey Wave			0.019			0.528			<0.001
wave 1	ref			ref			ref		
wave 2	1.08	(0.95, 1.23)	0.229	n/a			1.05	(0.88, 1.25)	0.620
wave 3	**1.26**	(1.09, 1.47)	0.002	1.12	(0.92, 1.37)	0.258	1.20	(1.00, 1.44)	0.056
wave 4	1.18	(1.00, 1.40)	0.055	1.08	(0.85, 1.38)	0.521	**1.81**	(1.48, 2.20)	<0.001
Image Type			<0.001			0.545			0.363
Suffering	ref			ref			ref		
Symbolic	**0.65**	(0.61, 0.69)	<0.001	n/a			n/a		
Graphic	**0.70**	(0.66, 0.74)	<0.001	0.98	(0.91, 1.05)	0.545	0.95	(0.86, 1.06)	0.363
Wave x Image interaction									0.027
wave 2 x symbolic	n/a			n/a			n/a		
wave 2 x graphic	n/a			n/a			0.92	(0.80, 1.05)	0.219
wave 3 x symbolic	n/a			n/a			n/a		
wave 3 x graphic	n/a			n/a			1.04	(0.90, 1.20)	0.624
wave 4 x symbolic	n/a			n/a			n/a		
wave 4 x graphic	n/a			n/a			**0.86**	(0.74, 0.99)	0.034
Negative Affects, β (95% CI)									
Survey Wave			0.629			0.027			0.044
wave 1	ref			n/a			ref		
wave 2	0.06	(-0.08, 0.20)	0.384	ref			0.00	(-0.14, 0.15)	0.950
wave 3	0.08	(-0.11, 0.28)	0.402	**0.22**	(0.03, 0.40)	0.021	-0.06	(-0.24, 0.13)	0.550
wave 4	0.03	(-0.23, 0.28)	0.837	**0.36**	(0.09, 0.63)	0.009	**-0.25**	(-0.47, -0.02)	0.031
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.85**	(-0.90, -0.80)	<0.001	n/a			n/a		
Graphic	**0.49**	(0.45, 0.52)	<0.001	**0.22**	(0.17, 0.27)	<0.001	**0.33**	(0.29, 0.35)	<0.001
Believability, β (95% CI)									
Survey Wave			0.812			0.162			0.247
wave 1	ref			n/a			ref		
wave 2	0.01	(-0.14, 0.17)	0.868	ref			-0.10	(-0.24, 0.04)	0.177
wave 3	0.04	(-0.18, 0.26)	0.722	0.15	(-0.06, 0.36)	0.155	-0.09	(-0.25, 0.08)	0.301
wave 4	-0.04	(-0.31, 0.24)	0.787	0.29	(-0.01, 0.56)	0.057	-0.18	(-0.38, 0.01)	0.064
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.65**	(-0.74, -0.56)	<0.001	n/a			n/a		
Graphic	**-0.43**	(-0.51, -0.35)	<0.001	**-0.22**	(-0.30, -0.14)	<0.001	**-0.24**	(-0.28, -0.21)	<0.001

Outcomes, Independent Variables	CANADA			AUSTRALIA			MEXICO		
	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*	est	*95% CI*	*P>z*
Wave x Image interaction			0.039			0.012			
wave 2 x symbolic	0.00	(-0.12, 0.12)	0.998	n/a			n/a		
wave 2 x graphic	0.02	(-0.08, 0.13)	0.677	n/a			n/a		
wave 3 x symbolic	0.07	(-0.05, 0.19)	0.254	n/a			n/a		
wave 3 x graphic	0.03	(-0.08, 0.13)	0.645	0.09	(-0.01, 0.19)	0.092	n/a		
wave 4 x symbolic	**0.15**	(0.03, 0.27)	0.012	n/a			n/a		
wave 4 x graphic	**0.14**	(0.03, 0.24)	0.009	**0.16**	(0.05, 0.26)	0.003	n/a		
Quit Motivation, β (95% CI)									
Survey Wave			0.646			0.062			0.263
wave 1	ref			n/a			ref		
wave 2	0.04	(-0.12, 0.20)	0.630	ref			0.04	(-0.12, 0.20)	0.624
wave 3	0.12	(-0.09, 0.34)	0.264	0.21	(0.00, 0.43)	0.052	-0.03	(-0.24, 0.18)	0.769
wave 4	0.08	(-0.19, 0.34)	0.577	**0.34**	(0.05, 0.63)	0.021	-0.17	(-0.42, 0.09)	0.195
Image Type			<0.001			<0.001			<0.001
Suffering	ref			ref			ref		
Symbolic	**-0.96**	(-1.01, -0.90)	<0.001	n/a			n/a		
Graphic	-0.01	(-0.05, 0.03)	0.478	**0.18**	(0.12, 0.23)	<0.001	**-0.07**	(-0.10, -0.03)	<0.001
Discussion about PHWs, OR (95% CI)									
Survey Wave			0.638			0.393			0.225
wave 1	ref			ref			ref		
wave 2	0.85	(0.65, 1.11)	0.224	n/a			1.12	(0.95, 1.32)	0.172
wave 3	0.89	(0.68, 1.18)	0.430	0.92	(0.75, 1.13)	0.441	0.97	(0.82, 1.17)	0.731
wave 4	0.96	(0.73, 1.27)	0.792	0.84	(0.65, 1.08)	0.172	1.06	(0.89, 1.27)	0.518
Image Type			<0.001			<0.001			0.004
Suffering	ref			ref			ref		
Symbolic	0.83	(0.67, 1.01)	0.063	n/a			n/a		
Graphic	**1.41**	(1.20, 1.65)	<0.001	**0.53**	(0.46, 0.61)	<0.001	**0.94**	(0.90, 0.98)	0.004
Wave x Image interaction			0.021			0.006			
wave 2 x symbolic	0.98	(0.75, 1.29)	0.888	n/a			n/a		
wave 2 x graphic	0.98	(0.79, 1.22)	0.847	n/a			n/a		
wave 3 x symbolic	0.97	(0.72, 1.30)	0.842	n/a			n/a		
wave 3 x graphic	0.87	(0.69, 1.09)	0.232	1.05	(0.87, 1.26)	0.634	n/a		
wave 4 x symbolic	1.04	(0.78, 1.38)	0.795	n/a			n/a		
wave 4 x graphic	**0.70**	(0.57, 0.88)	0.002	**1.33**	(1.10, 1.61)	0.004	n/a		

Note: est, estimate; β, regression coefficient; OR, odds ratio; CI, confidence interval; n/a, not applicable;
Interaction and stratification models were adjusted. Adjustment variables include: age, sex, educational level, income level, quit intention in the next 6 months, quit attempt, Heaviness of Smoking Index, daily smoking status, time in sample, and race (Canada only).

Country	PHW Imagery Type		
	Suffering	Symbolic	Graphic
Canada			
Australia *		*Not included*	
Mexico		*Not included*	

Notes:
* Included only PHWs from the first set of 7 new health warnings on standardized packaging implemented in December 2012 in Australia.

All images are in the public domain, as they are images that are printed on cigarette packs that you can purchase in each country. For that reason, they can be used for research purposes, and they can be published in scientific manuscripts without permission

Figure 1. Study stimuli for each country, by imagery type.

215x279mm (300 x 300 DPI)

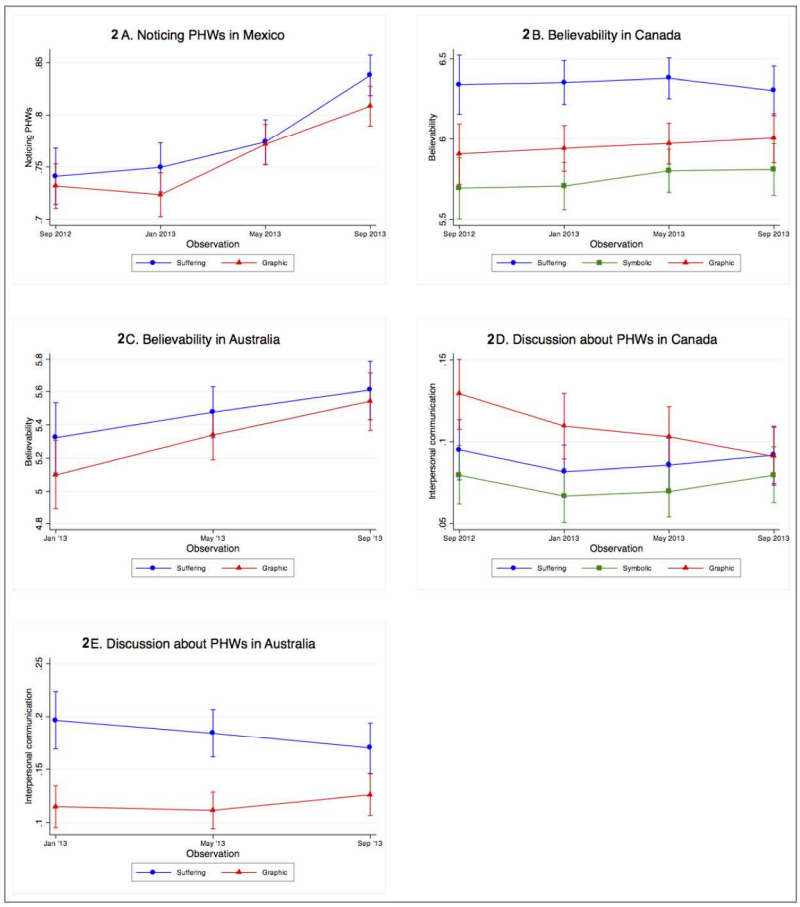

Figure 2. Trends of noticing, believability, and discussion of PHWs.

209x296mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6, 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8, 9
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9, 10
		(*b*) Describe any methods used to examine subgroups and interactions	9, 10
		(*c*) Explain how missing data were addressed	9, 10
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	6

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10, 22
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	22
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	10-12
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	-
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-12
		(*b*) Report category boundaries when continuous variables were categorized	7, 10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	16-17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 2. Percentage or Mean (SE) level for each outcome by survey wave and by imagery type

Outcomes, Survey waves	**CANADA**				**AUSTRALIA**			**MEXICO**		
		Imagery Type				Imagery Type			Imagery Type	
	Wave	*Graphic*	*Suffering*	*Symbolic*	Wave	*Graphic*	*Suffering*	Wave	*Graphic*	*Suffering*
Noticing PHWs, %										
Sep 2012	55.82	59.40	66.57	56.30	n/a	n/a	n/a	72.07	71.73	73.07
Jan 2013	62.12	64.25	72.99	63.40	82.16	81.78	82.91	74.39	73.37	76.07
May 2013	64.14	66.76	74.15	64.86	80.67	80.82	80.36	76.97	76.81	77.24
Sep 2013	62.74	64.85	71.51	63.79	79.23	79.32	79.07	81.11	79.95	83.03
Negative Affects, Mean (SE)										
Sep 2012	5.37 (0.03)	5.74 (0.04)	5.25 (0.04)	4.35 (0.06)	n/a	n/a	n/a	6.09 (0.03)	6.19 (0.03)	5.82 (0.05)
Jan 2013	5.36 (0.03)	5.73 (0.05)	5.21 (0.05)	4.39 (0.06)	4.99 (0.03)	5.04 (0.04)	4.89 (0.06)	6.06 (0.03)	6.19 (0.03)	5.86 (0.04)
May 2013	5.32 (0.03)	5.68 (0.05)	5.17 (0.05)	4.36 (0.06)	4.93 (0.03)	5.01 (0.04)	4.76 (0.06)	5.96 (0.03)	6.07 (0.03)	5.77 (0.04)
Sep 2013	5.27 (0.03)	5.61 (0.05)	5.16 (0.04)	4.36 (0.06)	4.98 (0.03)	5.07 (0.04)	4.81 (0.06)	5.91 (0.03)	6.03 (0.03)	5.71 (0.04)
Believability, Mean (SE)										
Sep 2012	6.07 (0.03)	5.99 (0.05)	6.42 (0.04)	5.77 (0.06)	n/a	n/a	n/a	6.80 (0.03)	6.75 (0.03)	6.97 (0.05)
Jan 2013	6.01 (0.03)	5.93 (0.05)	6.34 (0.04)	5.70 (0.06)	5.35 (0.03)	5.28 (0.04)	5.50 (0.06)	6.74 (0.03)	6.64 (0.03)	6.90 (0.04)
May 2013	5.98 (0.03)	5.89 (0.05)	6.28 (0.04)	5.74 (0.06)	5.39 (0.03)	5.35 (0.04)	5.47 (0.06)	6.68 (0.02)	6.58 (0.03)	6.86 (0.04)
Sep 2013	5.97 (0.03)	5.94 (0.05)	6.22 (0.04)	5.73 (0.06)	5.36 (0.04)	5.35 (0.04)	5.40 (0.06)	6.63 (0.02)	6.54 (0.03)	6.78 (0.04)
Quit Motivation, Mean (SE)										
Sep 2012	5.07 (0.03)	5.21 (0.05)	5.27 (0.05)	4.22 (0.06)	n/a	n/a	n/a	6.07 (0.03)	6.07 (0.03)	6.09 (0.06)
Jan 2013	5.05 (0.03)	5.22 (0.05)	5.19 (0.05)	4.30 (0.06)	4.46 (0.04)	4.51 (0.05)	4.37 (0.07)	6.16 (0.03)	6.13 (0.04)	6.22 (0.05)
May 2013	5.04 (0.03)	5.20 (0.05)	5.17 (0.05)	4.29 (0.06)	4.47 (0.04)	4.55 (0.04)	4.32 (0.07)	6.03 (0.03)	6.01 (0.04)	6.08 (0.05)
Sep 2013	4.99 (0.03)	5.13 (0.05)	5.16 (0.05)	4.22 (0.06)	4.58 (0.04)	4.63 (0.05)	4.46 (0.07)	5.97 (0.03)	5.94 (0.04)	6.01 (0.05)

Outcomes, Survey waves	CANADA				AUSTRALIA			MEXICO		
		Imagery Type				Imagery Type			Imagery Type	
	Wave	*Graphic*	*Suffering*	*Symbolic*	Wave	*Graphic*	*Suffering*	Wave	*Graphic*	*Suffering*
Discussion of PHWs, %										
Sep 2012	14.75	17.86	13.07	12.18	n/a	n/a	n/a	31.65	31.00	33.56
Jan 2013	10.50	12.89	9.32	8.14	18.31	14.90	24.98	32.32	31.52	33.61
May 2013	9.96	11.37	9.50	8.06	13.14	10.85	17.73	30.56	30.16	31.22
Sep 2013	10.32	10.49	10.00	9.24	13.91	12.47	16.81	31.66	31.36	32.14