Original investigation

Framing Pictorial Cigarette Warning Labels to Motivate Young Smokers to Quit

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Abstract

Introduction: The Family Smoking Prevention and Tobacco Control Act requires new pictorial warnings for U.S. cigarette packs, but enactment has been delayed by tobacco industry lawsuits. Research can inform implementation of the pictorial warning requirement and identify ways to optimize their public health impact post-implementation. This study investigated the impact of warning label message framing on young smokers' motivation to quit, examining cessation self-efficacy, and perceived risks as moderators of message framing impact.

Methods: Smokers ages 18–30 ($n = 740$) completed baseline measures and were randomized to view 4 images of cigarette packs with pictorial health warnings featuring gain- or loss-framed messages. Motivation to quit was assessed after participants viewed the pack images. Linear models accounting for repeated measures and adjusting for baseline covariates examined the impact of message framing and interactions with baseline self-efficacy to quit and perceived risks of smoking.

Results: Loss-framed warnings prompted significantly greater motivation to quit among smokers with high self-efficacy compared with smokers with low self-efficacy. Among smokers with low self-efficacy, gain-framed messages were superior to loss-framed messages. Gain-framed warnings generated significantly greater motivation to quit among smokers with high perceived risks compared with smokers with low perceived risks. Among smokers with high perceived risks, gain-framed messages were superior to loss-framed messages.

Conclusions: A combination of pictorial warnings featuring risk-based (i.e., loss-framed) and efficacy-enhancing (i.e., gain-framed) information may promote better public health outcomes. Research is needed to investigate how strategically framed warning messages impact smokers' behaviors based on their pre-existing attitudes and beliefs in real-world settings.

Introduction

Cigarette smoking remains the leading preventable cause of death in the United States, where an estimated 45 million adults smoke cigarettes and where smoking accounts for nearly half a million preventable deaths annually.¹ Tobacco companies spend billions of dollars each year marketing their products, and due to increasing marketing restrictions cigarette packaging has become a mainstay marketing channel.² Consequently, cigarette packaging regulations including health warning labels and standardized packaging requirements are critical tobacco control measures. Unfortunately, cigarette packaging regulations in the United States have permitted the tobacco industry to leverage cigarette packs to promote their products largely unrestricted and have remained unchanged since the 1980s.³

The 2009 Family Smoking Prevention and Tobacco Control Act authorized the U.S. Food and Drug Administration (FDA) to regulate tobacco products, including their labeling. The Tobacco Control Act requires new pictorial warning labels on U.S. cigarette packs and enables the FDA to update the contents of the warnings to optimize their public health impact.⁴ Unfortunately, tobacco industry lawsuits have delayed implementing the new pictorial warning labels, postponing important progress to bring U.S. cigarette pack warnings in line with international standards.⁵ Most recently, the FDA chose not to appeal an August 2012 U.S. Court of Appeals ruling striking down the nine pictorial warnings proposed by the agency. Now, the FDA is pursuing additional research to support implementation of the Tobacco Control Act's warning label requirement.⁴ Research that can inform this aspect of tobacco regulation includes studies to determine how to best design warning messages to enhance their public health impact.³ These studies are important before and after implementing the pictorial warnings to ensure they promote optimal public health outcomes, such as promoting quit attempts and motivating smoking cessation.³

According to the message framing postulate of Prospect Theory, framing warning messages in terms of the costs of engaging in smoking behaviors (i.e., loss-framed) or the benefits of quitting smoking (i.e., gain-framed) will differentially affect smoking-related outcomes.⁶ Research generally suggests that gain-framed messages aimed at promoting health and reducing risk factors are advantageous over loss-framed messages for encouraging health-protective behaviors, such as quitting smoking.^{7,8} Despite this evidence, research to date has focused predominantly on pictorial cigarette warnings with loss-framed messages emphasizing the health risks of smoking (e.g., "smoking causes cancer").³ Three recent investigations compared cigarette warning labels with loss-framed messages to gain-framed alternatives, but the methods used to do so varied substantially and the findings of these studies are equivocal.⁹⁻¹¹ This highlights a need for additional research to inform FDA tobacco regulation by investigating how to best frame messages for pictorial cigarette warning labels.

Although research tends to favor gain-framed messages for smoking cessation, studies also indicate that individual-level factors including smoking-related attitudes and beliefs can moderate message framing effects.¹¹⁻¹⁴ Informed by the Extended Parallel Process Model (EPPM),¹⁵ a recent meta-analysis showed the impact of loss-framed appeals is increased when such messages also include content to promote efficacy beliefs that behavior change leads to positive outcomes or engender self-efficacy for behavior change.¹⁶ Another meta-analysis of cigarette warning label research drew similar conclusions, showing that loss-framed appeals are impactful among smokers with high efficacy beliefs (e.g., self-efficacy to quit) and

gain-framed messages are most impactful among smokers with high perceived risks.¹⁷ In line with the EPPM, these studies suggest loss-framed messages may be more likely to motivate cessation among smokers with strong pre-existing efficacy beliefs about quitting smoking (e.g., self-efficacy) whereas warnings with gain-framed messaging could be more likely to motivate cessation among smokers who already recognize the health risks associated with the behavior. In sum, this research points to pre-existing efficacy beliefs and risk perceptions as potential moderators of warning message framing effects, but this hypothesis has not been empirically evaluated.

Young adults stand out as a group where pictorial warnings could be effective at reducing smoking. Nearly 20% of U.S. young adults ages 18–30 are current smokers and many transition to regular smoking during this time.¹ Quitting smoking by age 30 reduces the lifetime risk of tobacco-associated disease to nearly that of a non-smoker,¹⁸ but few young adults successfully quit.¹⁹ Tobacco companies have carefully crafted cigarette packs to cultivate brand identification among young adults, making cigarette packs an important marketing vehicle to promote smoking in this population.²⁰ However, research to optimize the impact of pictorial warning labels among young adults has lagged.^{3,21-23} In light of the research described above, this study sought to aid in understanding what types of warnings will promote optimal public health outcomes among young adult smokers by examining the moderation effects of self-efficacy to quit smoking and perceived risks of smoking on cigarette warning label message framing.

Methods

Setting and Sample

The study analyzed data from an experiment conducted in 2013 to investigate the impact of pictorial cigarette warning message framing and other packaging regulations on motivation to quit among 740 smokers ages 18–30 in the United States. A complete description of the study is available elsewhere.¹⁰ Smokers within the target age range were recruited to participate through a research panel maintained by YouGov, Inc. The panel is comprised of more than 1 million U.S. adults who are recruited through online advertisements, email promotions, and other methods to participate in online research studies. The study used a purposive sampling design that used national health survey data to create quota estimates for the proportion of young adult smokers in strata based on age, race/ethnicity, and education.¹⁰ These strata proportions were used to target study invitations and monitor accrual to ensure demographic diversity.

Young adults were invited to take part in the experiment through an email containing a link to a description of the study and an online informed consent form. Those who consented to participate responded to three questions to confirm their age and assess smoking status. Participants who indicated they were between 18 and 30 years of age, had smoked at least 100 lifetime cigarettes and currently smoked all or some days were eligible to participate. The overall response rate among eligible young adults was 19%, similar to other young adult internet-based smoking studies.²⁴

Experimental Procedures

Consented participants completed a series of baseline measures and were then randomly assigned to four study conditions within a two-by-two factorial design. Participants viewed four images of cigarette packs that were manipulated along two dimensions for the experiment: (a) text of the warning messages was either gain- or

loss-framed, and (b) packs featured either branded or standardized “plain” packaging. Gain- and loss-framed warnings included the same images, however the text of the gain-framed warnings was manipulated for the experiment. For this study, our primary research question was to examine the potential moderation effects of baseline self-efficacy and perceived risks on warning message framing. We adjusted for the packaging manipulation in multivariable analyses, which did not have a significant effect on our results. Findings with respect to the packaging manipulation are reported elsewhere.¹⁰

The cigarette pack images were shown on a single screen in the online experiment and participants viewed the images for as long as they wished. Each pack image displayed a pictorial warning message covering 50% of the pack consistent with the requirements of the Tobacco Control Act. Warnings were based on four of the nine final warnings proposed for use by the FDA conveying the health risks of smoking including lung disease, cancer, heart attack and stroke, and mortality. These four warnings were chosen for the study because they have performed well among young adults in prior studies.^{21,25} Loss-framed warnings were those proposed by the FDA and were not adapted. Based on message framing research,⁷ gain-framed warnings were created for the experiment. Gain-framed warnings used the same images from the FDA warnings, but the text was manipulated to emphasize the benefits of quitting smoking. Additional details of the experimental manipulations, manipulation checks, and the complete stimulus materials are available elsewhere.¹⁰ Examples of gain- and loss-framed warnings are included as [Supplementary Material](#).

To account for smokers’ brand preferences in the design, pack images used an unfamiliar brand that was not available on the U.S. market.⁹ Pack dimensions were sized to that of a standard U.S. cigarette pack and presented in a consistent order for all participants. The primary outcome was assessed immediately as participants viewed the pack images. The Georgetown University Institutional Review Board approved all study procedures.

Measures

Demographics

Demographics assessed at baseline included gender, age, race/ethnicity, educational attainment, marital status, and household income.

Smoking Behaviors

Smoking behaviors measured at baseline using standard survey items included cigarettes smoked per day, daily or non-daily smoking, and participants’ preferred cigarette brand.²⁶

Perceived Risks of Smoking

Perceived risks of smoking were assessed using three valid items from prior research.²⁷ The items captured smokers’ perceptions that smoking is likely to harm their health, how much they think their health has been harmed by smoking, and the chance of getting a serious smoking-related disease. Responses were based on a five-point Likert-type scale with higher values indicating greater perceived risk. Responses to the items were averaged to create a summary score ($M = 3.69$, $SD = 0.86$, Cronbach’s $\alpha = 0.74$). We used a median split ($Mdn = 3.67$) to create a dichotomous high or low perceived risks variable for analyses.

Self-Efficacy

Self-efficacy to quit smoking was measured at baseline with two items from a prior study.²⁸ Items assessed smokers’ confidence they could quit smoking in the next 3 months and how easy they perceived

it would be to quit smoking in the next 3 months. Responses were based on a seven-point scale and were averaged to create a summary score with higher values indicating greater self-efficacy ($M = 4.10$, $SD = 1.72$, Cronbach’s $\alpha = 0.82$). A median split ($Mdn = 4.00$) was used to create a binary high or low self-efficacy variable.

Baseline Motivation to Quit

Motivation to quit at baseline was measured before participants viewed packs with gain- and loss-framed warnings and was included in analyses as a covariate. It was assessed using four reliable and valid items with responses on a four-point Likert-type scale ranging from “Definitely will not” to “Definitely will” quit. Items were averaged to create a summary score (Cronbach’s $\alpha = 0.89$) where higher values indicate greater motivation to quit smoking.

Outcome Variable

The primary outcome for analyses was motivation to quit assessed immediately in response to the cigarette packs featuring pictorial warnings with gain- and loss-framed messages. In response to each of the pack images, participants answered a question assessing how much the pack motivated them to quit smoking using a 1- (“Not at all”) to 7- (“A lot”) response scale.²⁴ For bivariate analyses, we averaged participants’ reported motivation to quit for the four pack images to assess associations with variables of interest ($M = 4.82$, $SD = 1.83$, Cronbach’s $\alpha = 0.92$). For multivariable analyses, we analyzed participants’ responses to each item individually using methods to account for the within-participant correlated nature of the data (see statistical analysis description).

Statistical Analysis

Our statistical analysis occurred through several steps. We examined associations between baseline characteristics, message framing, candidate moderator variables, and the average motivation to quit outcome variable using bivariate tests (i.e., t tests, X^2 tests, F tests). Next, we used multivariable regression analysis to test the hypothesized moderation relationships between baseline self-efficacy to quit and perceived risks of smoking and message framing. We used linear models with generalized estimating equations adjusting standard errors and test statistics to account for the correlated nature of the data due to repeated outcome measures in response to the four cigarette pack images.²⁹ We created two separate models to independently examine the potential moderation effects of baseline self-efficacy and perceived risks on warning message framing. In Model 1, we included an interaction between message framing (gain or loss) and an indicator of high or low baseline self-efficacy. Similarly, in Model 2 we assessed the interaction between message framing and high or low baseline perceived risks. In preliminary analyses, we created single model including the three-way interaction between message framing, self-efficacy, and perceived risks and all possible two-way interactions between these terms. The two- and three-way interactions were not statistically significant (all p ’s $> .15$) in this model, so we describe the results of separate models. Pair-wise least square means in motivation to quit were inspected based on the interaction findings. Baseline motivation to quit, demographics, and smoking-related characteristics that were associated with outcomes in bivariate analyses ($p < .05$) were included in the models as covariates. We also adjusted for the plain packaging manipulation that was part of the original two-by-two experimental design,¹⁰ although this factor did not contribute significantly to either model.

Results

Sample Characteristics

Table 1 displays characteristics of the sample. Participants averaged 23.8 ($SD = 3.1$) years of age, about half were female, three-quarters were non-Hispanic White, and most had less than a college education. Participants smoked an average of 9.2 ($SD = 8.9$) cigarettes per day, and nearly two-thirds smoked daily (Table 1). There were no significant differences in demographic or smoking-related characteristics based on whether participants were randomized to view warnings with gain- or loss-framed messages, indicating successful randomization (data not shown).

Bivariate Associations

Table 1 displays bivariate associations with follow-up motivation to quit. The patterns of results were similar across motivation to quit items in response to each of the four warnings viewed, so associations with average motivation to quit are shown for conciseness. Motivation to quit in response to the warnings was significantly

higher among participants who identified with a non-White racial/ethnic group, and those who were married or in a partnership, full-time employed, and those reporting an annual household income $\geq$ US\$ 50,000/year (Table 1). Motivation to quit was higher among respondents with high baseline self-efficacy and high baseline perceived risks of smoking, varied by smokers' preferred cigarette brand, and was higher among those smoking fewer cigarettes per day and those with stronger baseline motivation to quit.

Multivariable Models

Table 2 displays results of the regression models examining interactions between message framing and baseline self-efficacy to quit smoking (Model 1) and baseline perceived risks of smoking (Model 2). Models adjusted for baseline motivation to quit and demographic and smoking-related characteristics associated with outcomes, and accounted for aspects of the experiment that were not focal to this investigation. In both models, main effects were significant for race, cigarette brand, and baseline motivation to quit. The main effect for

Table 1. Sample Characteristics and Bivariate Associations with Motivation to Quit

Demographics	Study sample ($n = 740$)	Association with follow-up motivation to quit ^a		
		$M (SD)$	Correlation (r)	p value
Gender				.930
Male	55.5% (411)	4.8 (1.8)		
Female	44.6% (329)	4.8 (1.9)		
Age $M (SD)$	23.8 (3.1)		−0.01	.888
Race				<.001
Non-Hispanic White	74.9% (554)	4.6 (1.9)		
Non-Hispanic Black	10.7% (79)	5.7 (1.4)		
Other minority	14.4% (107)	5.3 (1.6)		
Education				.248
College +	27.7% (205)	4.9 (1.6)		
< College	72.3% (535)	4.8 (1.9)		
Marital status				.032
Married/partnership	31.3% (231)	5.1 (1.7)		
Single–never married	64.4% (476)	4.7 (1.9)		
Other	4.3% (32)	4.5 (2.0)		
Employment				.030
Full-time employed	38.0% (281)	5.0 (1.7)		
Other/not employed	62.0% (468)	4.7 (1.9)		
Income				.014
$\geq$ \$50,000/year	29.5% (218)	5.1 (1.6)		
< \$50,000/year	63.1% (467)	4.7 (1.9)		
No data/prefer not to say	7.4% (55)	4.3 (2.1)		
Self-efficacy to quit				<.001
High	43.8% (324)	5.1 (1.8)		
Low	56.2% (415)	4.6 (1.8)		
Perceived risks of smoking				<.001
High	46.8% (346)	5.3 (1.6)		
Low	53.2% (394)	4.4 (4.2)		
Cigarettes/day	9.2 (8.9)		−0.07	.038
Baseline motivation to quit	2.6 (0.78)		0.33	<.001
Smoking status				.410
Daily Smoker	63.8% (472)	4.8 (1.8)		
Nondaily smoker	36.8% (268)	4.9 (1.9)		
Preferred brand				<.001
Camel	18.5% (137)	4.8 (1.8)		
Marlboro	44.3% (328)	4.8 (1.9)		
Newport	16.2% (120)	5.3 (1.7)		
Other	21.0% (155)	4.4 (1.8)		

^aMotivation to quit outcome averaged across the four cigarette pack images

Table 2. Regression Models Examining Interactions Between Message Framing and Baseline Self-Efficacy and Perceived Risks

	Model 1 Interaction with self-efficacy to quit		Model 2 Interaction with Perceived risks of smoking	
	B (95% CI)	p value	B (95% CI)	p value
White race	-.74 (-1.00, -.47)	<.001	-.80 (-1.06, -.54)	<.001
Non-White race	Ref.		Ref.	
Full time employed	.10 (-.15, .35)	.443	.08 (-.17, .33)	.529
Other/not employed	Ref.		Ref.	
Marital status				
Married/partnered (1)	.58 (-.14, 1.30)	.113	.52 (-.18, 1.21)	.144
Single (2)	.18 (-.53, .88)	.623	.16 (-.52, .84)	.648
Other (3)	Ref.		Ref.	
Household income				
> \$50,000/year (0)	.28 (.04, .51)	.021	.38 (-.16, .91)	.165
<= \$50,000/year (1)	-.36 (-.73, .01)	.060	.57 (.02, 1.13)	.044
Don't know/not reported (2)	Ref.		Ref.	
Cigarettes per day	-.004 (-.02, .01)	.600	-.02 (-.03, -.01)	.011
Cigarette brand				
Camel (1)	.44 (.07, .81)	.019	.41 (.05, .78)	.027
Marlboro (2)	.44 (.13, .75)	.006	.39 (.08, .69)	.012
Newport (3)	.79 (.40, 1.18)	<.001	.66 (.28, 1.04)	<.001
Other (4)	Ref.		Ref.	
Baseline motivation to quit	.68 (.51, .86)	<.001	.58 (.40, .76)	<.001
Low self-efficacy/perceived risks	-.65 (-1.09, -.22)	.003	-.36 (-.80, .08)	.110
High self-efficacy/perceived risks	Ref.		Ref.	
Gain-framed message	-.13 (-.50, .25)	.511	.41 (.06, .76)	.020
Loss-framed message	Ref.		Ref.	
Message framing*Self-efficacy/perceived risks	.53 (.02, 1.04)	.043	-.48 (-.99, .03)	.063
Branded packaging	-.03 (-.26, .21)	.832	-.01 (-.24, .22)	.932
Plain packaging	Ref.		Ref.	

Note. CI = confidence interval.

self-efficacy was significant in Model 1, and the main effect for message framing was significant in Model 2 (Table 2).

In Model 1, after adjusting for baseline motivation to quit and demographic- and smoking-related characteristics, there was a statistically significant interaction between baseline self-efficacy and message framing ($Z = 2.02$, $p = .043$). Table 3 displays results of the adjusted pair-wise means comparisons based on self-efficacy and message framing. Among participants who viewed pictorial warnings with gain-framed messages, there was no statistically significant difference in motivation to quit based on their baseline self-efficacy to quit. In contrast, among participants who viewed warnings with loss-framed messages, those with high baseline self-efficacy to quit reported significantly greater motivation to quit ($M = 5.0$, $SE = .22$) compared to those with low self-efficacy to quit at baseline ($M = 4.3$, $SE = .22$, $p = .003$). Additionally, among participants with low baseline self-efficacy to quit, warnings with gain-framed messages produced stronger motivation to quit ($M = 4.7$, $SE = .17$) compared to warnings with loss-framed messages ($M = 4.3$, $SE = .22$, $p = .026$).

In Model 2, after adjusting for baseline motivation to quit, and demographic- and smoking-related characteristics, the interaction between baseline perceived risks of smoking and warning message framing approached statistical significance ($Z = 1.86$, $p = .063$). Table 3 shows results of post-hoc comparison of adjusted pair-wise means. Among participants who viewed warnings with gain-framed messages, those with high baseline perceived risks reported significantly greater motivation to quit ($M = 5.2$, $SE = .17$) compared to those with low baseline perceived risks ($M = 4.4$, $SE = .16$, $p < .001$). In contrast, among participants who viewed warnings with loss-framed messages, there was no statistically significant difference in

follow-up motivation to quit based on their perceived risks of smoking. Additionally, among participants with high baseline perceived risks, warnings with gain-framed messages prompted significantly greater motivation to quit ($M = 5.2$, $SE = .17$) compared to warnings with loss-framed messaging ($M = 4.8$, $SE = .21$, $p = .020$).

Discussion

This study investigated the impact of gain- and loss-framed messaging for pictorial cigarette warning labels among young adult smokers, examining the moderation effects of smokers' baseline self-efficacy to quit smoking and perceived risks of smoking. Pictorial warnings featuring gain- and loss-framed text had a differential impact on motivation to quit based on smokers' pre-existing self-efficacy to quit smoking and perceived risks of smoking. These results suggest that at the population level, pictorial warnings with graphic imagery depicting smoking-related health risks and a strategic mix of gain- and loss-framed message text may promote optimal public health outcomes for young smokers.

The gain-framed messages we evaluated combined graphic imagery depicting the health risks of smoking and text emphasizing the positive benefits of quitting. Among smokers with low baseline efficacy beliefs (i.e., with room to increase their self-efficacy to quit), warnings with gain-framed messaging prompted greater motivation to quit, suggesting they may do so by enhancing efficacy beliefs. Among smokers with high perceived risks (i.e., with little room to change perceptions that smoking is hazardous), gain-framed messages emphasizing the benefits of cessation were also superior to loss-framed messages focusing on risks, suggesting that messaging

Table 3. Adjusted Mean (Standard Error) Motivation to Quit by Baseline Characteristics and Warning Message Framing

Model 1			Model 2		
Baseline self-efficacy	Gain-framed (A)	Loss-framed (B)	Baseline perceived risks	Gain-framed (A)	Loss-framed (B)
High (C)	4.8 (.18)	5.0 (.22) ^D	High (C)	5.2 (.17) ^{B,D}	4.8 (.21) ^A
Low (D)	4.7 (.17) ^B	4.3 (.22) ^{A,C}	Low (D)	4.4 (.16) ^C	4.5 (.22)

Note. Motivation to quit was measured using a scale ranging from 1 to 7. Higher values indicated stronger motivation. Superscript letters adjacent to means indicate statistically significant differences at $p < .05$ in pair-wise comparisons of adjusted means by message framing across rows (A,B) and down columns (C,D). Means are adjusted for baseline motivation to quit, cigarettes smoked per day, preferred cigarette brand, demographics (race/ethnicity, income, employment, and marital status), and other aspects of the experimental design.

to bolster cessation efficacy beliefs motivates cessation for smokers who already recognize tobacco-related health risks.

The loss-framed messages we evaluated were taken from the final nine warnings proposed by the FDA. They featured pictorial content depicting smoking-related health risks and message text warning of these health risks. For smokers with high pre-existing self-efficacy to quit, these warnings prompted stronger cessation motivation compared with smokers with low pre-existing self-efficacy to quit. This finding suggests that for smokers who are confident they can quit, warnings conveying the health risks of smoking fosters stronger motivation to do so. Taken together, our results are consistent with EPPM and indicate a messaging combination featuring imagery depicting the health risks of smoking and both gain- and loss-framed message text could be particularly effective to maximize impact on outcomes relevant to promote public health (e.g., motivating cessation, quit attempts) and minimize potential maladaptive responses to pictorial warnings (e.g., avoidant behaviors, potential boomerang effects).¹⁵ To build from this study, prospective research examining changes in self-efficacy and perceived risks of smoking as intermediary pathways between warning message framing and motivation to quit is needed.

Two studies recently examined message framing in the context of cigarette warning labels. One study compared gain- and loss-framed warnings in a series of forced choice tasks where smokers and non-smokers reviewed pairs of experimentally adapted cigarette packs and reported on various pack choice outcomes.⁹ Nonsmokers reported that packs with loss-framed warnings were more likely to attract attention, promote thoughts about health risks, motivate quitting, and were more effective in general. However, this study only examined gain- and loss-framed messages for text-only cigarette warnings, not pictorial warnings. In another recent experiment, Zhao et al.¹¹ found that, compared to gain-framed warnings, pictorial loss-framed messages were perceived by young smokers to be more effective, elicited stronger emotional reactions, and promoted more negative thoughts about smoking. In the pictorial warning conditions, the researchers manipulated framing of the images and text. Our study builds from these investigations in important ways. We examined subtle changes to the framing of the text of warning messages, but we did not adapt the pictorial content. The results highlight the importance of independently evaluating the pictorial and text elements of framed warning messages. We also investigated potential moderation effects of young smokers' pre-existing self-efficacy to quit smoking and beliefs about health risks of smoking. The findings demonstrate the need to account for smokers' pre-existing beliefs when examining the impact of framed warning messages.

Other findings from this study may also be useful to inform future research and policy decision-making. Notably, participants who were non-White and who smoked Newport cigarettes consistently

reported stronger motivation to quit in response to the pictorial warnings. Newport is a popular menthol cigarette brand in the United States, and racial/ethnic minority smokers, particularly Black, commonly smoke menthol cigarettes.³⁰ Research suggests menthol cigarettes contribute to youth smoking initiation³¹ and may inhibit cessation,³² which makes racial/ethnic minority menthol smokers particularly vulnerable to long-term health effects of smoking. Our findings suggest pictorial warnings could be especially impactful for reducing smoking among racial/ethnic minority young adults. This finding is consistent with other prior experimental studies (e.g., Hammond et al.²⁵), but requires additional investigation to determine why this might be the case and how to best leverage packaging regulations as a strategy to reduce tobacco-associated disparities.

Our results should be interpreted with respect to the study limitations. While the sampling strategy was devised to maintain demographic diversity, participants were members of an online panel and this could affect generalizability. We investigated message framing by adapting the text of the warning messages only, and other approaches to message framing (e.g., gain-framed imagery) should be investigated in future studies. In the experiment all four cigarette pack images were shown on a single screen, therefore we were unable to determine whether ordering of the pack images may have affected our findings. We captured motivation to quit smoking in response to a single, brief exposure to pictorial warnings in an online survey. Prospective experiments employing ecologically-valid designs to capture the real-world impact of pictorial warnings on smokers' behaviors will help to bolster this evidence base.³³ Objective assessments of smokers' reactions to pictorial warnings, such as eye tracking^{34,35} and neuroimaging³⁶, may also be useful to address limitations of relying on self-report outcomes data.

Conclusions

A primary challenge tobacco regulators and public health officials face is deciding on the contents of warnings to maximize public health impact and how to best vary the contents of warnings over time for sustained effectiveness. Our results can inform this decision-making, suggesting that pictorial warnings featuring graphic images emphasizing smoking-associated health risks and varying message text to emphasize either the health risks of continuing to smoke or benefits of cessation may be optimal at the population level. To build from this work, additional research investigating how strategically framed warning messages impact smokers' behaviors can support FDA's implementation of pictorial warnings for cigarette packs. Experimental studies using prospective research designs to examine the effects of framed pictorial warnings in real-world settings can build from this work and advance understanding of the potential impact of pictorial warnings on smokers' behaviors.

Supplementary Material

Supplementary Material can be found online at <http://www.ntr.oxfordjournals.org>

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Declaration of Interests

None declared.

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