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Does segmentation really work? Effectiveness of matched graphic health warnings on cigarette packaging by race, gender and chronic disease conditions on cognitive outcomes among vulnerable populations

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Abstract

We examined the effects of audience segmentation by gender, race/ethnicity, and presence of chronic disease condition in the context of cigarette packaging graphic health warnings (GHWs). Specifically, we tested whether GHWs that portray these specific groups are associated with differences among smokers who match the portrayed group.

We used data from Project CLEAR, which oversampled lower socio-economic groups as well as race/ethnic minority groups living in the Greater Boston area (n=558). We fitted multiple linear regression models, controlling for age, education and household income. Gender was added as a control variable to fit models for race and chronic disease conditions.

Although Black race or Hispanic ethnicity was associated with higher risk perception and intention to quit smoking, we did not find evidence of a segmentation effect, i.e. Black or Hispanic viewers was not more likely to be responsive to warnings featuring same racial/ethnic subjects. Women who viewed GHWs portraying women reported increased risk perception as compared to women who viewed GHWs portraying men. The findings suggest that segmentation of GHWs may be effective for risk perception among women.

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ETHICAL APPROVAL

The IRB of the Harvard T.H. Chan School of Public Health provided the clearance for the study.

DECLARATION OF INTERESTS

None declared.

INTRODUCTION

Population disparities in smoking

In the United States, smoking prevalence has continued to decline from 42.4% in 1965 to 15.5 % in 2018 (Centers for Disease Control and Prevention, 2014, 2016a, 2016c; Jamal et al., 2018). However, smoking still remains the leading cause of disease and death in the US. Moreover, the effects of smoking fall disproportionately on already disadvantaged groups, generally lower socioeconomic status (SES) groups as well as racial, ethnic and sexual minorities (Centers for Disease Control and Prevention, 2016b). Although smoking rates among African Americans are lower than that of Whites in some surveys, African Americans have lower rates of successful smoking cessation (Centers for Disease Control and Prevention, 2011; Smoking Cessation Leadership Center University of California San Francisco, 2016). While Hispanics have lower smoking rates than Whites, these rates vary by sub-groups among Hispanic (Caraballo, Yee, Gfroerer, & Mirza; Smoking Cessation Leadership Center University of California San Francisco, 2016). For example, Puerto Ricans (28.5%) have higher smoking rates than other Latino groups from Central or South American (20.2%), Cuba (19.8%) or Mexico (19.1%) (Centers for Disease Control and Prevention, 2016b, 2017). Disparities in health insurance coverage (and hence disparities in access to healthcare providers and smoking cessation treatments) may account for these group differences in quitting behavior (Centers for Disease Control and Prevention, 2017). Smoking rates among men (16.7%) are higher than those for women (13.6%) (Centers for Disease Control and Prevention, 2016a); however, female smokers are more likely to have a higher risk of disease burden as compared to male smokers (Syamlal, Mazurek, & Dube, 2015). For example, women tend to have adverse health and cognitive outcomes. Female smokers have higher risk of developing coronary heart disease (CHD), chronic obstructive pulmonary disease (COPD), asthma and higher incidence of lung cancer as compared to male smokers (Freedman, Leitzmann, Hollenbeck, Schatzkin, & Abnet, 2008) as well as poorer self-rated physical and emotional health (Huxley & Woodward, 2011). These disparities in smoking call for programs to prioritize disadvantaged groups (Hornik & Ramirez, 2006). Health communication campaigns targeting specific audiences have been used as one approach to address the disparities (Hornik & Ramirez, 2006). Evidence has shown that disadvantaged groups have less access, and lower ability to understand, process and take action on health information (Viswanath, 2006). Furthermore, these communication inequalities are associated with smoking-related knowledge, belief and outcomes (Cantrell et al., 2013).

The effectiveness of graphic health warnings (GHWs) in vulnerable populations

In 2012, under the 2009 Family Smoking Prevention and Tobacco Control Act, U.S. Food and Drug Administration (FDA) announced the requirement of graphic health warnings (GHWs) which are intended to cover 50% of the cigarette package to warn about health risks (National Institutes of Health, 2017). GHWs have been successfully implemented more than 100 countries (Brewer, Hall, & Noar, 2016; Canadian Cancer Society, October 2016; Gibson et al., 2015; Huxley & Woodward, 2011; Noar, Hall, & Francis, 2016). GHWs on cigarette packs are considered to be one of the more powerful ways to reduce smoking disparities (Gibson et al., 2015; Hammond, 2011; Hill, Amos, Clifford, & Platt, 2014; Trasher et al.,

2012). The effectiveness of GHWs for vulnerable populations has been well-documented in terms of both cognitive and behavioral intention outcomes such as risk perception, credibility and intention to quit smoking (Cantrell et al., 2013). GHWs are considered an effective tool for communicating risk to smokers at the point of behavior; graphic rather than text-only warnings appear to enhance the effects of messages across different groups (Hammond, 2011; Thrasher et al., 2012). Specifically, pictorial images depicted in GHWs are believed to enhance cognitive processing regardless of the level of audience literacy, language proficiency, culture and prior health knowledge (Cantrell et al., 2013). However, it is unknown whether a GHW depicting a subject matched to a specific sub-group is particularly effective for the intended audience. For instance, are GHWs with images depicting a person of color, or a crying woman, or someone breathing through a ventilator more or less likely to be effective for smokers of color, women, or people with chronic disease conditions, respectively? Surprisingly, to our knowledge, there are very few studies that assessed this targeted effect, which is the focus of our investigation – i.e. whether GHWs depicting a particular group works more or less effectively among members of that targeted group. In particular, we investigated whether exposure to GHWs with a particular image can have increased effects on cognitive outcomes such as risk perception and intention to quit smoking for the audience depicted in the images, in terms of race, gender and chronic disease condition.

Communication campaign development and segmentation

In order to convey messages effectively, segmentation has been used in marketing and advertising. Segmentation is the process of categorizing diverse populations into sub-groups which have similar backgrounds, demographic and psychological characteristics, as well as experiences, among other differences (Institute of Medicine, 2002). By doing so, audiences can find more relevance (recognition of having similar traits, attitudes, or sharing an identity of the membership) and salience in the messages, and it can increase the effectiveness of communication by leading people to pay more attention, process messages more deeply, and take action (Eagly & Chaiken, 1993; Institute of Medicine, 2002; Kreuter, Bull, Clark, & Oswald, 1999; Wilder, 2017). Segmentation is frequently employed in communication campaigns (Institute of Medicine, 2002). Specifically, the concepts called audience-character similarities and source-receiver similarities have been widely used in the public health, and demonstrated positive effects (Durantini, Albarracín, Mitchell, Earl, & Gillette, 2006; Kim, Shi, & Cappella, 2016).

Anti-smoking communication and segmentation

The use of audience segmentation to develop targeted advertisements to promote smoking has been used for a long time by the tobacco industry (National Cancer Institute, 2008). There are some examples of segmentation and targeting of subgroups in anti-smoking campaigns. However, few studies have discussed or documented the effects of segmentation and targeting for GHWs (Tharp-Taylor, Fryer, & Shadel, 2013). Among those that exist related to anti-smoking campaigns in general, there have been mixed findings. Except for limited segmentation effects for women, other studies demonstrate no significant differences in campaign and/or health warning effectiveness by race/ethnicity, gender, age (Cantrell et al., 2013; Durkin, Brennan, & Wakefield, 2012; Gibson et al., 2015; Miller, Quester, Hill, &

Hiller, 2011; Tharp-Taylor et al., 2013), income or education (Cantrell et al., 2013), with the exception of one study showing that women and younger smokers may find relevance in the advertisement when it portrays women (Miller et al., 2011). There are also literatures showing that women's heightened responses to images of babies as compared to men's responses to these images (Kollath-Cattano, Osman, & Thrasher, 2017; O' Hegarty, Pederson, & Nelson, 2006). Furthermore, some literature even pointed the negative effect due to racial segmentations to address disparities (Hornik & Ramirez, 2006). Also, previous study demonstrated that the unified approach is better than segmenting in influence smoking cessation (Parvanta, Gibson, Moldovan-Johnson, Mallya, & Hornik, 2013). Some studies even conclude that segmentation and targeted messages are not advisable when considering the additional cost for campaign development and potential negative effects such as stigmatization (Hornik & Ramirez, 2006). In terms of practice, segmentation requires additional resources such as time, cost and people to develop different versions. Thus, when segmentation is used for anti-smoking messaging, an extra level of consideration, whether it is more effective and also not even harmful, is needed.

The aim of the study

The purpose of this study was to evaluate segmentation effects in GHW. We define segmentation as matching the message on some relevant audience characteristic. Specifically, we aim to investigate whether GHWs with an image representing a member or an image typifying a specific sub-group are more or less effective for the intended audience. We sought to investigate 1) whether GHWs portraying particular groups (race, gender, and chronic disease conditions) work more or less effectively for risk perception among the target audiences (Research Question 1 [RQ1]) and 2) whether GHWs portraying specific groups work to boost intentions to quit (Research Question 2 [RQ2]). To assess this segmentation effect, we were specifically interested in segmentation effects among lower SES groups given barriers they face in accessing, processing and using health and risk information. As a theoretical framework, this analysis is informed by the Structural Influence Model (SIM) of health communication, which demonstrates the concept of communication inequalities. This theoretical model emphasizes that communication inequality can occur due to social determinants (i.e., gender, education, income, race/ethnicity), and it eventually affects health behavior and health outcomes (Viswanath, Ramanadhan, & Kontos, 2007).

METHODS

Data source and study population

The data for this study come from Project CLEAR. In order to study the impact of GHWs on both smokers and non-smokers, particularly among vulnerable populations, Project CLEAR aimed to assess the impact of GHWs among disadvantaged groups including: African Americans, Hispanics, low SES, chronic disease patients, lesbian, gay, bisexual and transgender (LGBT) individuals, and blue-collar workers. With the help of three Massachusetts-based community partners (Alliance for Community Health in Boston; Common Pathways in Worcester; and the Mayor's Health Task Force in Lawrence), this project was conducted between August 2012 and April 2014 in the Greater Boston area,

including Boston, Worcester, and Lawrence. Inclusion criteria for this study were people between the ages of 18 and 70, who speak English or Spanish. At the time of recruitment, we aimed to enroll 600 smokers. The recruitment of participants occurred with the help of the above-mentioned community organizations, by distributing flyers in their community locations and using word of mouth. Smokers were self-identified at recruitment through screening questions including smoking history in the past 30 days and self-identification of smoking status (1. Regular smoker, 2. Occasional smoker, 3. Ex-smoker, 4. Someone who tried smoking, 5. Non-smoker). Participants who answered that they had taken at least one puff in the past 30 days were considered smokers in this study, even if they identified themselves to be a non-smoker. For this study, we only analyzed data from smokers.

Survey development

A mixed-methods approach was used to develop the survey, including an extensive literature review, focus groups, and key informant interviews. The focus group and interviews referred to the overall CLEAR survey instrument, not the specific measures used for this analysis. The survey questions were drawn from measures used in past surveys. For participants with low literacy levels, the study used electronic tablets with the option of hearing the questions and answer choices through headphones, in addition to being shown questions and answer choices on the screen. Prior to actually fielding the experiment, cognitive testing was conducted to check both the survey instrument itself and the tablet delivery system.

Design

A randomized experimental design was used for this study. All participants were randomized to view one of nine GHW that were developed and chosen by the FDA (Appendix 1). First, each participant answered a pre-test survey that included demographic information, baseline smoking-related cognitive and behavioral measures, and chronic disease status. Second, the participants were randomized to be exposed to one of the nine GHWs, then answered questions to assess their level of perceived effectiveness, emotional reactions, intention to quit smoking, and further cognitive and behavioral responses.

The survey was completed by 565 participants (adults ages 18-70). It was conducted at community locations including senior centers, community colleges, trade unions and housing developments. Once the participants arrived on site, we asked them to complete eligibility forms and read the information about the study. For those whose eligibility was confirmed, we provided a consent form and they took survey through a computer or electronic tablet.

On the survey, first, they were asked demographic information and smoking related questions such as smoking status, habits, and beliefs. Then nine of the GHWs were shown (Appendix 1), followed by emotional responses and cognitive and behavioral questions including risk perception and intention to quit smoking. Then, they were asked about the effectiveness of the remaining eight labels. These labels were not used in the current analysis. Upon completion of the survey, a \$50 gift card was provided as an incentive. The study was approved by Harvard University's institutional review board.

Study variables

Independent variables:

Relevance for GHW: Relevance for GHWs with race, gender, and chronic disease condition was determined based on the graphic design on the label. We coded the 9 GHWs into three separate variables to indicate their relevance for different subgroups by race/ethnicity, gender, and having chronic diseases. For example, a GHW was determined to be relevant for Black or Hispanic populations when they depicted persons of color. The categorization of GHWs and relevance for GHWs (race, gender and chronic disease status) are shown in Appendices 1 and 2, respectively. Relevance for each GHW with the targeted audience was categorized as binary (1 –yes and 0 –no).

Race: Race and ethnicity were measured using two items. First, respondents were asked “Are you Hispanic, Latino/a, or Spanish origin? (Select One)”. The response choices were: 1) No, not of Hispanic, Latino/a, or Spanish origin, 2) Yes, Mexican, Mexican American, Chicano/a, 3) Yes, Puerto Rican, 4) Yes, Dominican, 5) Yes, Cuban, and 6) Yes, another Hispanic, Latino/a, or Spanish origin. This was followed by the sentence: “In the United States, Hispanic/Latino is not currently considered a race. It is considered an ethnicity. Even if you are Hispanic/Latino, please answer the following question by selecting the race or races that best describe you. What is your race? Select one or more”. The response choices were: 1) American Indian or Alaska Native, 2) Asian, 3) Black or African American, 4) Native Hawaiian or Other Pacific Islander, 5) White and 6) I do not identify with any of the above. Then, we categorized respondents as non-Hispanic White when they choose 1) no, not of Hispanic, Latino/a, or Spanish origin for the first item and 5) White for the second item, and as Black when they choose 1) no, not of Hispanic, Latino/a, or Spanish origin for the first item and 3) Black. People who answered Hispanic or Latino origin for the first question and any categories were categorized as Hispanic. The rest were categorized as “Other”. Those of “other” race and “other” chronic disease conditions were excluded.

Gender: Gender was asked by a question “What is your gender?”. The response choices were: 1) Male, 2) Female, 3) Transgender and 4) Other (please specify). For this study, respondents who answered either male or female were used for the analysis. A total of 11 people were omitted from the analysis.

Chronic disease condition/status: Chronic disease condition/status was measured by one item, “Do you currently have or have been diagnosed with (the following diseases/symptoms)?” Five responses were listed: cancer, depression or anxiety, trouble breathing, asthma or other lung disease (for example, emphysema or chronic bronchitis), heart disease including high blood pressure, effects of stroke, in addition to a space which indicated “other (specify)”. For this study, people who checked any one of the five listed diseases were categorized as having chronic disease condition/status.

Dependent variables:

Risk perception—Risk perception was asked directly after viewing the assigned GHW. People were asked to respond to this statement: “(the label) makes me think about the health risks of smoking” (Hammond et al., 2007). The response items were ranked on a 5-point

Likert scale from “strongly disagree, disagree, neither disagree nor agree, agree, to strongly agree”. We selected risk perception and intention to quit smoking as our dependent variables, as previous literature has established the relationship between the two variables (Hahn & Renner, 2007; Park et al., 2009; Savoy et al., 2014).

Intention to quit smoking—We measured intention to quit smoking via a question that indicated the readiness of quit smoking. Specifically, we asked “How likely is it that you will do each of the following in the next 30 days: try to quit smoking”. The response options were “not at all likely, somewhat likely, moderately likely, very likely, and extremely likely”. This item used the question from a previous study (DiClemente et al., 1991). This time period means that the respondent is in the preparation stage to change their behavior and ready to take an action, based on the Transtheoretical model (DiClemente et al., 1991; Glanz, Rimer, & Viswanath, 2008). The score was used as a continuous variable.

Risk perception and intention to quit smoking have been shown to be associated with starting, stopping smoking, and quit attempts (Borrelli, Hayes, Dunsiger, & Fava, 2010; Romer & Jamieson, 2001; Vabgeli, Stapleton, Smit, Borland, & West, 2011).

Covariates:

Age, gender, education and household income were used as covariates. When we assessed gender relevance and their outcomes, gender was not used as a covariate in order to avoid collinearity.

Statistical analysis

We conducted descriptive analysis to assess the sample population (Table 1). To investigate the relationship between relevance for GHWs and cognitive outcomes, we used multiple regression analyses. For each analysis, an interaction term was included to assess the moderation effect due to the relevance for the GHW and each independent variable (race, gender and chronic disease conditions, respectively). Covariates were different for the analysis on matching by gender (relevance for women). In this case, we only adjusted for age, income, and education, and not gender. For missing data, we used complete case analysis. We excluded individuals with at least one missing value for any of the variables used in the analysis (0.35% of the total participants). All analyses were performed using STATA 13.0 SE. For all analyses, we used two-sided p-value at 0.05 level.

RESULTS

The descriptive characteristics of the sample are summarized on Table 1. In total, there were 565 smokers in the sample (554 without missing data), aged 18 to 68. The average reported age was 34 years. The number of women was slightly less than men, but both accounted for approximately half of the population. Nearly 40% of the population was Hispanic, with Blacks and Whites accounting for approximately 30% each. In terms of education, people who completed high school accounted for 30%, the highest among all of the categories.

There are 11 respondents categorized as “other” race, and these were not included in the analysis. Nearly 25% of the respondents among smokers responded that their household income was under US\$10,000 in 2012.

The first research question is whether GHWs with the image of a particular group work more effectively for risk perception for the targeted audience, in terms of race, gender and chronic disease conditions. Results of the multiple linear regression result are shown in Table 2. The main effects model shows the main effect (without interaction). The adjusted model (the interaction model) shows the interaction between relevance for the GHW to the group and the respondent belonging to a certain group (being Black or Hispanic, being women, or having chronic disease conditions, respectively). In terms of race, the main effects model shows that being Black or Hispanic is associated with increased risk perception as compared to being White or others (coefficient: 0.34, $p=0.02$). However, the interaction term was not significant, i.e. GHWs depicting race/ethnic minority subjects were not more effective in the targeted groups. In terms of gender, the main effects were not significant. However, the gender x relevance interaction term was significantly associated with increased risk perception (coefficient: 0.60, $p=0.04$) (Figure 1). That is, GHWs depicting female smokers were more effective for women in terms of bolstering risk perception. In terms of chronic disease conditions, there is no association between having chronic disease and risk perception in the main effects model (coefficient: 0.55, $p=0.618$). However, relevance for chronic disease condition is associated with risk perception (coefficient 0.32, $p=0.014$). There is no interaction in the interaction model, meaning having chronic disease does not have additional effects.

Our second research question was whether the GHWs depicting images of a particular group works more effectively for intention to quit smoking among the intended audience, in terms of race, gender and chronic disease conditions. Table 3 shows the multiple linear regression results, adjusting for covariates. In terms of race and gender, in both the main effect model (without interaction) and the interaction model (with interaction terms), being Black or Hispanic (coefficient: 0.63, $p=0.0001$) and being a woman (coefficient: 0.41, $p=0.01$) were significant for intention to quit smoking. However, neither interaction terms were significant. With regard to chronic disease conditions, the relevance for chronic disease condition was not significant in the main effect model for intention to quit smoking (coefficient: 0.13, $p=0.327$). However, relevance for chronic disease condition is associated with intention to quit smoking (coefficient 0.41, $p=0.0001$). No interaction was found.

DISCUSSION

Does audience segmentation work for GHWs?

Although being Black or Hispanic was associated with higher risk perception and intention to quit smoking as compared to being White or “Other”, we found no segmentation effect. In terms of main effect, this finding is consistent with a previous study which showed that GHWs can be equally or more effective for disadvantaged groups (Cantrell et al., 2013). Also, these results address the concern from other studies about potential adverse effects due to the segmentation of target disadvantaged racial groups (Hornik & Ramirez, 2006). In this study, we did not find negative responses in terms of risk perceptions and intentions to quit

smoking due to segmentation by race, supporting the notion that targeting minority racial groups would not lead to untoward effects on these outcomes.

Women in the study expressed higher intention to quit smoking than men. Although the evidence is mixed, some studies have suggested that GHWs are more effective for women than men in terms of eliciting negative emotional reactions, cognitive reactions, and beliefs about health risks (Nonnemaker, Choiniere, Farrelly, Kamyab, & Davis, 2015). In terms of segmentation, our study found partial support. In other words, when female subjects were portrayed in GHWs, it increased risk perception in women (though not intentions to quit). Our result is consistent with a previous study suggesting that images of unborn babies and children create stronger emotional reactions in female smokers than male smokers (Kees, 2006; Kollath-Cattano et al., 2017; McQueen et al., 2015; Miller et al., 2011; O' Hegarty et al., 2006).

For both risk perception and intention to quit smoking, relevance of chronic disease condition-related GHWs worked more effectively than non-chronic disease GHWs. However, there was no segmentation effect. This suggests that regardless the participants' disease status, GHWs showing chronic disease conditions may be more effective than others in terms of evoking higher perceived risk and intention to quit regardless of the viewer's health status. There may be a possibility that people who have chronic disease in their family or friends may react to GHWs taking it personally, even though they themselves do not have disease conditions. This result would support the argument that unified messaging may be more effective than segmentation (Hornik & Ramirez, 2006; Parvanta et al., 2013).

Overall, our study provides weak evidence in support of audience segmentation by race, gender and chronic disease conditions except for a limited cognitive outcome for women. While designing anti-smoking advertisements, two issues need to be considered. First, we need consider the effectiveness of segmentation against the possibility of negative impacts including stigma and unfavorable outcomes. Our finding demonstrates that segmentation works partially for women in terms of boosting risk perception. Although no other groups (men, race/ethnic minorities, people with chronic conditions) responded differently to the ads, there did not appear to be any unintended outcomes (such as negative effects by matched GHWs). These considerations imply that a segmentation approach is effective for certain sub-groups without causing harm; at the same time, segmentation may not be necessary for GHWs to convey messages effectively to intended audiences. In addition, there is a concern about unfavorable outcomes by targeting a specific audience. Self-affirmation theory indicates that people tend to react defensively when their sense of self-integrity is threatened (Sherman & Hartson, 2011). This tendency has been seen among smokers (smoker's identity) (Steele, 1988; Zhao, Nan, Yang, & Iles, 2014). In the qualitative study conducted to develop this study questionnaire, some black women showed uncomfortable feelings towards the GHW portraying Black women. Thus, it is important to consider whether segmentation is necessary.

We tested whether segmentation works for the intended audiences (Black and Hispanic, women, and people having chronic diseases as considered as a disability and disadvantages in health). These audiences, such as racial and ethnic minorities, women, and the disabled,

are generally subject to discrimination and stigmatization (Krieger, 1999, 2000). There are concerns about stigmatization of disadvantaged minority groups due to anti-smoking campaigns, and it obscures the issue of social structure to generate these inequalities (Haines-Saah, Bell, & Dennis, 2015). Moreover, as the Structural Influence Model (SIM) argues, these vulnerable groups tend to be exposed to communication inequalities, which can lead to disadvantage for them in health outcomes (Viswanath et al., 2007). Discrimination, stigmatization and communication inequalities are contributors to health inequality (Krieger, 1999; Viswanath et al., 2007). GHWs are expected to address these disparities, especially for disadvantaged groups. In fact, in our study, GHWs were associated with stronger responses among Black or Hispanic for both risk perception and intention to quit smoking. Considering these groups' potential disadvantages in communication (e.g., information access, exposure, use, information seeking, and information processing) described in SIM (Viswanath et al., 2007), GHWs may be a powerful tool to overcome these barriers. This finding may strengthen the current evidence that GHWs may be helpful for disadvantaged groups.

A secondary consideration regarding segmentation is to weight the extra production costs against the benefits of adopting such an approach (Hornik & Ramirez, 2006). Public health funding is always limited. Thus, in order to create segmented GHWs, it is very important to assess the effect as a pilot test, then determine if the segmentation is really necessary. By focusing on particular segments, we may lose opportunities to create broader exposure, and mobilizing social norms that apply to the entire population rather than targeting a specific sub-group (Hornik & Ramirez, 2006).

Limitations

Some limitations of our study need to be borne in mind. Our study environment was different from natural settings in terms of seeing GHWs on actual cigarette packages. Our study was conducted using a tablet and we assigned and showed a GHW to participants only once. Thus the results might have been different if smokers are exposed multiple times to GHWs during the course of the day, as happens in a real-world setting (Rooke, Malouff, & Copeland, 2012). We used intention to quit smoking as a behavioral outcome indicator. However, there is a well-documented gap between people's intentions and actual quit behavior (Rise, Kovac, Kraft, & Moan, 2008). Only smokers were included in our analysis, and further research is needed to understand segmentation by different categories (e.g., psychological factors), different races (e.g., Black or Hispanic, separately) as well as the effectiveness of audience segmentation for non-smokers as well as other demographic groups (e.g. youth). The categorization of the label can be improved. We categorized labels based on our findings from the qualitative interviews. In terms of chronic disease conditions, we included current health conditions which are acute or single episode (e.g., trouble breathing, depression, anxiety). This may have prevented us from capturing people who had these episodes once (but not currently). In addition, the reaction of the people may be different whether they perceive certain diseases as tobacco-related or not. Generalizability needs to be tested in further study. Also, for further studies, it would be helpful to test using more precise measure of variables such as risk perception or labels by specific racial groups versus people of color, and also smoking related disease versus non-smoking related disease.

Strengths

Our study also contributes to a better understanding of audience segmentation of GHWs in several ways. First, there are a limited number of studies to test the FDA's GHW labels to investigate the segmentation effect on cognitive outcomes among vulnerable populations. There are existing studies about interaction effects within different sub-populations, however these studies have primarily focused on the overall effects of GHW exposure without considering the issue of matching (Bittencourt, Person, Cruz, & Scarinci, 2013; Guillaumier, Bonevski, & Christine, 2015; Guillaumier, Bonevski, Paul, Durkin, & D'Este, 2014; Mead, Cohen, Kennedy, Gallo, & Latkin, 2016; Trasher et al., 2012). Our study looked at GHWs matched with the population, so that it can more clearly demonstrate segmentation effect. This study focused on whether sub-group characteristics (race, gender, and chronic disease conditions) moderate the relationship between the relevance of GHWs (matched images) and cognitive outcomes, which enabled us to determine if the targeted GHW was more effective for the intended audiences. The results of the study have practical implications for reconsidering how to communicate with these groups about quitting smoking, and aiming to reduce disparities among sub-populations. Specifically, for female smokers to address the risk of smoking, use the targeted GHW for women may be effective. But for other groups (such as men, race, and people with chronic disease conditions), segmentation may not be necessarily. It is important to do pilot test before scaling up to assess the segmentation effects for the intended audience. Second, the population of this study represents the most disadvantaged groups for tobacco-related burden, and where urgent and effective intervention is most needed. GHWs are likely to be the most beneficial for these disadvantaged groups as they may contribute to redressing communication inequalities due to differences in access, understanding and processing health information (Cantrell et al., 2013). This study may help to deepen the understanding of a GHW's approach, especially among these lower-SES groups.

In conclusion, we did not find a substantial segmentation advantage effect of GHWs on risk perception and intention to quit smoking among smokers in terms of race and chronic disease conditions, except for gender (being a woman) for risk perception. The lack of a main effect for gender combined with the significant interaction effect of gender (in terms of risk perception) supports the notion that gender segmentation may be effective in the development of GHWs. This finding may be useful for developing targeted messages in practice, especially when there is a need to target female smokers (e.g., pregnant women) (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). Further studies are needed to understand whether this result is applicable to non-smokers and also for other smoking-cessation related variables, as well as to know the mechanisms of why gender-segmented GHWs are powerful for women. Also, testing in a real-world setting such as giving people cigarette packs with GHWs, and considering repeated exposure may help create more natural setting to test the effectiveness of GHWs. In addition, in order to assess the effectiveness of GHWs, prospective studies to examine smoking behaviors such as cessation and its maintenance as outcome are needed. These findings will help public health experts make a decision whether segmentation and targeted communication is truly necessary when developing GHWs and other anti-smoking communications.

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APPENDIX

Appendix 1: FDA's Graphic Health Warnings

Hole	Baby	Lung

Teeth	Stroke	Toon

Dead	Cry	Quit

Appendix 2: Categorization of relevance of race, gender and chronic disease conditions Race (Black or Hispanic or White and Others)

Matched characteristics (relevance for Black or Hispanic): 250

Hole	Baby	Toon	Cry
Unmatched characteristics (relevance for non-Black or Hispanic): 187

Stroke	Dead	Quit	

- The number shows the number of people who assigned to see any of labels in the category

Gender (woman or man)

Matched characteristics (relevance of woman) :119

Baby

Cry

Unmatched characteristics (relevance of non-woman- man): 269

Hole

Stroke

Dead

Quit

- The number shows the number of people who assigned to see any of labels in the category

Chronic disease conditions (having disease and disease symptoms or not)

Matched characteristics (relevance of chronic disease conditions- yes): 352

Hole	Lung	Teeth	Stroke

Dead			
Unmatched characteristics (relevance of no chronic disease conditions- no): 213

Baby	Toon	Cry	Quit

- The number shows the number of people who assigned to see any of labels in the category

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Figure 1.

Interaction between matched characteristics (relevance of GHWs for women and gender - being woman) for risk perception

- Relevance for women (No=0) means the exposure to GHW with male image
- Relevance for women (Yes=1) means the exposure to GHW with female image

Table 1.

Demographics, socioeconomic status, and health status among smokers (n=554)

		Smoker (554)	
Age		34.09 (18-68)	
		n	%
Gender	Men	301	53.45
	Women	253	44.96
Race	White	178	30.9
	Black	158	28.0
	Hispanic	218	39.3
Education	Completed grade school or less	28	5.05
	Some high school	76	13.72
	Completed high school	165	29.78
	Completed GED	85	15.34
	Some college	142	25.63
	Completed associate's degree	17	3.07
	Completed college	22	3.97
	Graduate or professional school after college	13	2.35
Household income in 2012	Don't know, or does not apply	6	1.08
	Under \$10,000	139	25.09
	\$10,000-\$19,999	90	16.25
	\$20,000-\$29,999	56	10.11
	\$30,000-\$39,999	53	9.57
	\$40,000-\$49,999	27	4.87
	\$50,000-\$59,999	24	4.33
	\$60,000-\$69,999	12	2.17
	\$70,000-\$74,999	7	1.26
	\$75,000 or above	20	3.61
Chronic disease condition (Currently have symptom/have been diagnosed)	Don't know	126	22.74
	Yes	259	46.75
	No	295	53.25
Smoking status (the number of cigarettes per day in the past 30 days)			
Did not smoke any		34	6.18
Less than 1 per day		54	9.82
1 cigarettes per day		47	8.55

2-5 cigarettes per day	152	27.64
6-10 cigarettes per day	118	21.45
11-20 cigarettes per day	111	20.18
More than 20 cigarettes per day	34	6.18
Risk perception (average)	3.89 (SD=0.05)	
Intention to quit smoking (average)	3.87 (SD=0.05)	

Table 2.

GHW's interaction effect on risk perception in relation to relevance for the GHW by race, gender and chronic disease condition) with interaction term among smokers (n=554)

Race				
Main effects model ^a			Interaction model ^b	
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	p-value
Relevance for Black or Hispanic	0.07	0.60	Relevance for Black or Hispanic	0.82
Black or Hispanic	0.34	0.02	Black or Hispanic	0.10
			Interaction (Relevance of Black or Hispanic * Black or Hispanic)	0.92
Gender				
Main effects model ^a			Interaction model ^b	
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	p-value
Relevance for women	-0.12	0.389	Relevance for women	0.05
Women	0.21	0.121	Women	0.853
			Interaction (Relevance for women* women)	0.04
Chronic disease conditions				
Main effects model ^a			Interaction model ^b	
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	p-value
Relevance for chronic disease condition	0.41	0.0001	Relevance for chronic disease condition	0.52
Chronic disease condition	0.55	0.618	Chronic disease condition	0.284
			Interaction (Relevance for chronic disease condition* chronic disease condition)	-0.21
				0.328

^aMain effects model was to investigate the effect of matched characteristics (the relevance for race, gender or chronic disease conditions), adjusting for age, gender, education, and household income (in case of gender, gender was not included as a confounder).

^bInteraction model was to investigate the interaction between relevance of race and participants' race, between relevance of gender and participants' gender, and the interaction between relevance of chronic disease and participants' chronic disease status, adjusting for age, gender, education, and household income (in case of gender, gender was not controlled for).

Table 3.

GHW's' interaction effect on intention to quit smoking in relation to matched characteristics (relevance of the GHW by race, gender and chronic disease condition) among smokers (n=554)

Race					
Main effects model			Interaction model		
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	Coefficient	p-value
Relevance for Black or Hispanic	-0.17	0.26	Relevance for Black or Hispanic	-0.19	0.45
Black or Hispanic	0.63	0.0001	Black or Hispanic	0.61	0.008
			Interaction (Relevance of Black or Hispanic * Black or Hispanic)	0.04	0.89
Gender					
Main effects model			Interaction model		
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	Coefficient	p-value
Relevance for women	-0.28	0.10	Relevance for women	-0.11	0.609
Women	0.41	0.01	Women	0.53	0.006
			Interaction (Relevance of women* women)	-0.40	0.247
Chronic disease conditions					
Main effects model			Interaction model		
Predictor variable	Coefficient	p-value	Predictor variable and interaction term	Coefficient	p-value
Relevance for chronic disease condition	0.32	0.014	Relevance for chronic disease condition	0.13	0.49
Chronic disease condition	0.13	0.327	Chronic disease condition	-0.09	0.67
			Interaction (Relevance for chronic disease condition* chronic disease condition)	0.36	0.17

^aMain effects model was to investigate the effect of matched characteristics (the relevance for race, gender or chronic disease conditions), adjusting for age, gender, education, and household income (in case of gender, gender was not included as a confounder).

Interaction model was to investigate the interaction between relevance of race and participants', race, between relevance of gender and participants', gender, and the interaction between relevance of chronic disease and participants', chronic disease status, adjusting for age, gender, education, and household income (in case of gender, gender was not controlled for).

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