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Sex Differences in Graphic Warning Label Ratings by Addictions Clients

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Objectives: Research on sex differences in response to cigarette graphic warning labels (GWLs) has been limited despite tobacco-related health disparities for women. We examined whether women had stronger responses to certain labels than to others, whether this pattern differed from men's, and whether there were overall sex ratings differences. **Methods:** Smokers (N = 881) in 24 addictions treatment programs rated 3 of 9 Food and Drug Administration-developed labels on credibility, message reactance, quit motivation, and negative emotions. Participants rated one label depicting a woman and/or baby, and 2 depicting tobacco-related disease or male images. **Results:** Women's (N = 432) ratings of labels depicting women/babies versus other labels did not differ from men's (N = 449) ratings. Women had higher ratings than men across all labels combined on credibility ($p < .001$), quit motivation ($p = .007$), and negative emotions ($p < .001$). Individual labels were analyzed for sex differences. Women's ratings were higher on credibility for 3 of 9 labels, and on negative emotions for 7 of 9 labels. **Conclusions:** Female smokers in addictions treatment had generally stronger responses to GWLs than men, supporting GWL implementation in the United States to help close the sex gap in smoking cessation.

Key words: addictions treatment; sex differences; packaging; vulnerable populations; warning labels
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Tobacco control efforts have contributed to a substantial decline in smoking prevalence in the United States (US) from approximately 40% in 1965 to 15.5% in 2016.[1,2] Passage of the Family Smoking Prevention and Tobacco Control Act (TCA) in 2009 expanded regulatory efforts to include implementation of pictorial health warnings on cigarette packages by the Food and Drug Administration (FDA). However, litigation brought by the tobacco industry[3] blocked implementation of 9 pictorial warning labels selected by the FDA.[4] The FDA is supporting research to strengthen evidence that such labels reduce smoking initiation and promote quitting.[5] The US is playing "catch up" in this regard; 105 countries have already implemented the use of pictorial health warnings.[6] Research to date supports their effectiveness. Graphic warning labels (GWLs) on cigarette packages have been associated with increased perception of the health risks of smoking,[7] increased quit attempts,[8-10] lower smoking intentions and initiation among youth,[11,12] decreases in smoking relapse,[13] and decreases in smoking prevalence.[8,14] In experimental studies, smokers exposed to GWLs on cigarette packs for 4 weeks were significantly more likely than controls to make

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a quit attempt[9] or to begin a smoking cessation intervention.[15]

Women experience significant health disparities related to smoking.[16] Despite no overall sex difference in quit attempts, women have lower rates of successfully quitting[17,18] and experience greater risk of certain health consequences of smoking than men (eg, coronary heart disease).[19] There is a need for sex-focused study in all areas of tobacco research, including the study of GWLs, to identify interventions that improve smoking cessation rates among women.

Message segmentation strategies are health communications intended to reach subpopulations by targeting group-relevant interests, concerns and experiences. They have shown promise in reducing health disparities, prompting recommendations to identify audience segments and target messages to those groups.[20-22] Sex-based segmentation employing GWL images depicting harms of smoking to women, pregnant women and babies may be personally relevant for women, and thereby, more effective for them than for men or than other images. Research findings from general population samples generally support this hypothesis. We identified one study showing no sex differences[23] and 4 in which women's ratings of pregnancy or baby images differed from men's ratings.[24-27] In these studies, women rated the images higher in believability and motivation to quit or remain abstinent, as well as more effective in discouraging smoking than men.[24-27]

Women with substance use disorders (SUDs), other than tobacco only, smoke at rates 3-4 times higher than the general population[28] and have lower rates of successful cessation.[17,18,29] They have been underserved regarding treatment of co-morbid smoking and other substance use,[30] while also being targeted by tobacco marketing,[31,32] a combination of factors supporting proposals for their designation as a tobacco use disparities group.[16,33] Developing effective tobacco control strategies for this vulnerable population is particularly important for increasing quit rates and reducing tobacco-related health disparities. Both regulatory efforts and targeted treatment interventions are likely needed to increase smoking cessation among women smokers with additional SUDs. Although study of GWLs within this population has just begun, initial evidence suggests GWLs have some positive behavioral impact. Smokers in residential SUD treatment who used GWL cigarette packs for 30 days reported greater readiness to quit and were significantly more likely to attend a smoking cessation group session than those who used transparent label packs.[15] The study did not report examination of sex differences. However, a qualitative study of GWL reactions among persons in addiction treatment did report sex-specific reactions, including heightened responses by women to an image of a baby. The image evoked memories and negative feelings, indicative of its personal relevance for some female respondents.[34] This finding, within a vulnerable, high-smoking group, corresponds with quantitative studies in the general population of smokers showing women's heightened responses to images of babies relative to men's responses.[24-27]

The current study examined ratings of GWLs by male and female smokers as part of a tobacco use and attitudes survey of adult clients in SUD treatment across the US. Based on prior studies, including the qualitative study findings of Pagano et al,[34] we sought to identify potential sex-related differences in ratings of GWLs. Survey respondents viewed FDA-selected GWLs depicting a woman and/or a baby, tobacco-related disease, or male images. We examined whether women responded more strongly than men to images of women and/or babies relative to their responses to other images on 4 measures assessing commonly used constructs in GWL ratings (credibility, message reactance, motivation to quit, and negative emotions). We then examined whether women responded differently than men overall on these measures. Thirdly, we examined whether women and men responded differently to individual GWLs.

METHODS

Sampling Design and Participants

The survey was administered from March to November 2016 to 1153 participants enrolled in 24 publicly funded, adult SUD treatment programs (10 residential/inpatient, 7 methadone maintenance, and 7 outpatient clinics) across the US providing treatment for individuals whose primary substance use disorder was not tobacco. All programs were affiliated with the National Drug Abuse Treatment Clinical Trials Network (CTN) (https://www.drugabuse.gov/about-nida/organi-

zation/cctn/ctn/about-ctn), a national network of 13 research centers and affiliated treatment programs, conducting community-based research to improve patient outcomes. Participating programs were randomly selected, stratified by program type (inpatient/residential, methadone maintenance, outpatient), from among 48 possible programs meeting inclusion criteria. Programs eligible for study participation were publicly funded, had a census of at least 60 active patients, and were willing to assign a staff study-liaison. Participating programs received a $2000 incentive following the survey site visit. All patients enrolled in treatment for at least 10 days and present the day the survey was conducted were eligible to participate. The number of participants recruited from each clinic ranged from 32 to 55. Participants provided informed consent, completed surveys, and then received a $20.00 gift card. Details of sampling design, program selection and recruitment can be found in a previous paper.[35]

Procedure and Measures

Participants used iPads linked to a secure university server to complete self-administered surveys. Items used for the current analysis included demographic questions regarding age, sex (ie, female, male, other), race/ethnicity, marital status, employment status, and education. Respondents reported their primary drug and their smoking status. Current smoking was defined as reporting current smoking and lifetime smoking of at least 100 cigarettes. Each participant who identified as a current smoker viewed 3 GWLs from among the 9, FDA-selected GWLs presented in Figure 1. Labels included statements of negative health effects (addiction, disease causation, death, harm to children) and one positively framed message ("Quitting smoking now greatly reduces serious risks to your health"), specified for inclusion by the TCA. Images depicted a woman and/or a baby, a man, or tobacco-related disease.

Each participant viewed one GWL randomly selected from a subset of 3 depicting either a woman and/or baby (top of Figure 1) and 2 GWLs randomly selected from the remaining subset depicting a man or tobacco-related disease (bottom of Figure 1). The parent survey required about 40 minutes to complete. We presented 3 GWLs rather than all 9 to each participant to manage the time burden of the full survey.

Participants were shown one label at a time and asked to rate it on 4 scales: credibility, message reactance, motivation to quit, and negative emotions. Each scale contained from 1 to 4 items. Items were rated using a 4-point Likert scale as has been done in other studies.[22,36] Possible response options included 1 = not at all, 2 = a little, 3 = somewhat, and 4 = a lot. Participants could also select "I don't know" on any item and could check "decline to answer" when rating negative emotions. "I don't know" and "decline to answer" were recorded as missing values.

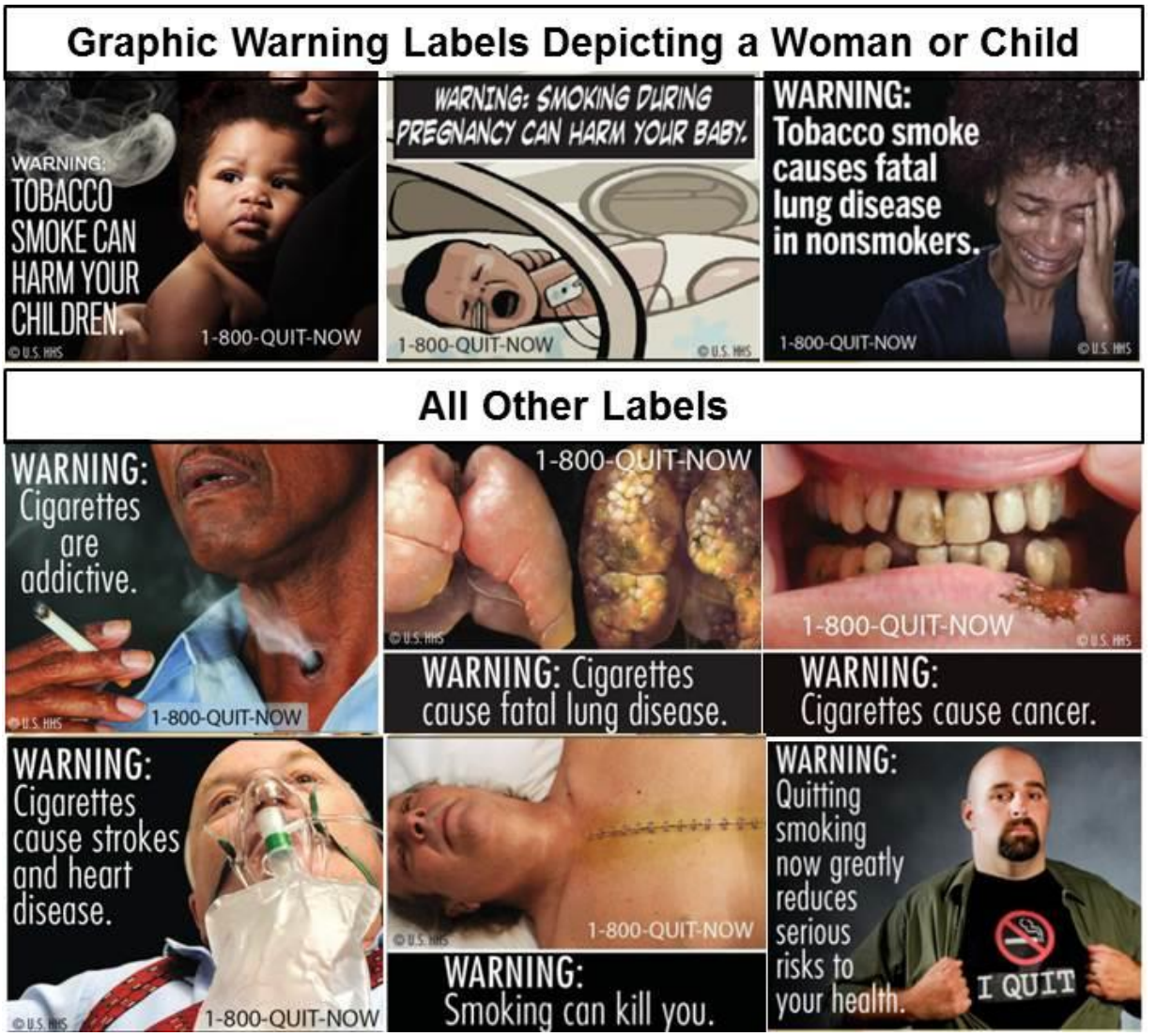
Credibility. This score was based on the mean of 3 items: The label is informative, is based on facts, and increases my understanding of smoking risks. This measure was adapted from prior research on credibility as a mediator of effects of warning labels on quit intentions and smoking-related outcomes.[36,37] Internal consistency for this measure was good (Cronbach's $\alpha = .85$).

Message reactance. Two items assessed clients' tendency to react defensively to labels: "The label presented misleading information" and "The label exaggerates the health risks of smoking." The 2 items were moderately correlated ($r = .59$) suggesting reasonable internal consistency. We used the mean of the 2-items as the scale score. A low score on this measure indicated a positive response, (ie, label not perceived as misleading). This measure was modified from prior research,[38] and is based on evidence of individuals' attempts to reduce fear aroused by a message via dismissal, counterarguments, or avoidance of fear-generating information.[38-40]

Motivation to quit. One item assessed motivation to quit (ie, "The label makes me want to quit smoking"). GWLs have been found to increase quit intentions,[41] which in turn, have been associated with quit attempts[42] and smoking cessation.[43]

Negative emotions. Participants rated each label ("Please tell us what you *felt* when looking at this label") on 4 negative emotions: sad, angry, disgusted, and guilty. The negative emotion score was the mean of the 4 emotions rated (Cronbach's $\alpha = .91$). This measure was based on a similar scale used in health communications research.[44] Negative emotions have been shown to mediate perceived risk, desire to smoke and quit intention responses to GWLs,[36,37]and have predicted reduced smoking satisfaction and lower cigarette consumption.[45]

Figure 1
Nine FDA-approved Graphic Warning Labels



Data Analyses

The total sample included 1153 respondents. Some participants (N = 6) did not identify as either male or female, and some (N = 7) did not complete GWL ratings. Of the remaining cases, 881 (77.3%) identified as current smokers, including 449 men and 432 women who comprised our sample. They smoked an average of 13.2 (SD = 8.47) cigarettes per day and began smoking on average at 15.2 years old (SD = 4.47). They were compared on demographic variables (ie, age, race/ethnicity, education, marital status and employment status) and primary drug for which they entered treatment using a t-test for continuous variables and a chi-square test for categorical variables to inform subsequent analyses.

To evaluate whether women responded more strongly than men to GWLs depicting a woman and/or baby compared to other GWLs, we calculated the mean difference between ratings by label type (woman and/or baby vs all other labels) for women and men. Sex differences in the difference

Table 1
Demographics and Primary Drug Use for Female and Male Smokers in Substance Use Disorders Treatment

Variables	Male (N = 449)	Female (N = 432)	Total (N = 881)	p-value
Age	38.9 (11.85)	35.8 (10.53)	37.4 (11.32)	< .001
Race/ethnicity				.028
Hispanic	62 (13.8%)	50 (11.6%)	112 (12.7%)	
Non- Hispanic Black	82 (18.3%)	52 (12.0%)	134 (15.2%)	
Non- Hispanic White	243 (54.1%)	270 (62.5%)	513 (58.2%)	
Non- Hispanic Other	62 (13.8%)	60 (13.9%)	122 (13.8%)	
Education				< .001
<HS[a]	108 (24.1%)	92 (21.4%)	200 (22.8%)	
HS/GED[a]	194 (43.2%)	138 (32.1%)	332 (37.8%)	
>HS	147 (32.7%)	200 (46.5%)	347 (39.5%)	
Marital status				< .001
Married	47 (10.5%)	56 (13.0%)	103 (11.7%)	
Divorced/Separated/Widowed	107 (23.8%)	129 (29.9%)	236 (26.8%)	
Not married but in long term relationship	96 (21.4%)	117 (27.1%)	213 (24.2%)	
Never married	199 (44.3%)	130 (30.1%)	329 (37.3%)	
Employment status				.122
Yes	132 (29.4%)	107 (24.8%)	239 (27.1%)	
No	317 (70.6%)	325 (75.2%)	642 (72.9%)	
Primary drug of use				.005
Alcohol	89 (19.8%)	74 (17.1%)	163 (18.5%)	
Stimulants	80 (17.8%)	120 (27.8%)	200 (22.7%)	
Opiates	226 (50.3%)	197 (45.6%)	423 (48.0%)	
Other	54 (12.0%)	41 (9.5%)	95 (10.8%)	

Note.
a: HS refers to high school. GED refers to General Educational Development certificate.

scores were compared on each of the 4 measures (credibility, message reactance, motivation to quit, negative emotions) using t-tests.

Second, we examined whether there were any sex differences in ratings for all 9 GWLs combined to assess the more general question of whether men and women responded differently in overall ratings. We calculated a score for each participant on each measure (credibility, message reactance, motivation to quit, negative emotions) using the mean rating of the 3 GWLs each participant viewed. Linear mixed effects regression models with random intercept were applied to assess the relationship between each measure and sex. Parameters were estimated using Restricted Maximum Likelihood (REML) method. These models controlled for variables that were statistically significant at a 0.10 alpha level in the univariate analysis by sex (ie, age, race/ethnicity, education, marital status, and primary drug). Models also accounted for nesting of participants within clinic.

Last, we applied linear mixed effects regression models with random intercept to assess the relationships between each of the 3 measures that showed statistically significant overall sex differences (credibility, motivation to quit, negative emo-

Table 2
Women's and Men's Difference Scores for Ratings of Women/Babies versus Other Labels

	Women's Difference Scores (Ratings of Women/Babies vs Other Labels)	Men's Difference Scores (Ratings of Women/Babies vs Other Labels)	p-value
Credibility	-0.078	0.015	.089
Motivation to Quit	-0.241	-0.206	.610
Message Reactance	0.053	0.058	.940
Negative Emotions	-0.0004	-0.025	.630

tions) and sex for each of 9 GWLs. These models also controlled for age, race/ethnicity, education, marital status, primary drug and accounted for nesting participants within clinic. We conducted 27 comparison tests (9 labels over the 3 measures) and applied the False Discovery Rate procedure to control the possible Type I error rate inflation. Because the rate of missing data was low (3.5%), the multivariable models used complete case analysis. The total number of cases included in the models for overall measures (credibility, message reactance, motivation to quit, negative emotions) were 873, 863, 876, 850, respectively. All analyses were conducted using SAS version 9.3.

RESULTS

Comparison of Responses to GWLs of Women and/or Babies versus Other Labels by Sex

Table 1 shows the comparisons of demographic characteristics by sex. Male and female participants differed significantly on age, race/ethnicity, education, marital status and primary drug; these were included as control variables in analyses of GWL ratings. In testing women's difference scores (ie, ratings of GWLs depicting women and/or babies vs other GWLs) compared to men's difference scores, we found no sex-based differences on any of the 4 measures. Table 2 shows these results.

Comparisons of Overall Responses to GWLs by Sex

Table 3 summarizes the results of linear mixed effects regression models comparing the overall ratings of GWLs by sex. The models adjusted for age, race/ethnicity, education, marital status, primary drug, and accounted for nesting participants within clinic. Women had consistently higher ratings than men on 3 of the 4 ratings measures: credibility

Table 3
Comparisons of Overall Ratings of Graphic Warning Labels by Sex

	Unadjusted Mean (SD)			Adjusted Mean[a]	
	Total	Women	Men	Adjusted Mean Difference (95%CI) (Women vs Men)	p-value
Credibility	3.02 (0.76)	3.13 (0.71)	2.93 (0.78)	0.22 (0.12, 0.33)	**< .001**
Motivation to Quit	2.55 (1.01)	2.63 (0.97)	2.46 (1.03)	0.21 (0.06, 0.35)	**.007**
Message Reactance	1.95 (0.88)	1.89 (0.88)	2.01 (0.88)	-0.06 (-0.18, 0.07)	.359
Negative Emotions	2.52 (0.93)	2.70 (0.90)	2.34 (0.93)	0.38 (0.25, 0.52)	**< .001**

Note.
a: Adjusted for age, race/ethnicity, education, marital status, primary drug use and controlling for nesting of participants within clinics.

Table 4
Comparison of Ratings for Individual Graphic Warning Labels by Sex

Graphic Warning Label	Credibility		Motivation to Quit		Negative Emotions	
	Un-adjusted Mean (SD) (Total)	Adjusted Mean Difference (95%CI) (Women vs Men)[a,b]	Unadjusted Mean (SD) (Total)	Adjusted Mean Difference (95%CI) (Women vs Men)[a]	Unadjusted Mean (SD) (Total)	Adjusted Mean Difference (95%CI) (Women vs Men)[a,b]
Lung Disease	3.22 (0.86)	0.16 (-0.06, 0.38)	2.82 (1.14)	0.06 (-0.23, 0.36)	2.55 (1.07)	0.33 (0.04, 0.62)
Gum Disease	3.14 (0.85)	**0.41 (0.20, 0.63)****	2.73 (1.19)	0.33 (0.01, 0.65)	2.57 (1.07)	**0.46 (0.18, 0.73)***
Heart Disease	3.14 (0.88)	0.18 (-0.04, 0.40)	2.65 (1.18)	0.22 (-0.08, 0.53)	2.56 (1.09)	**0.35 (0.08, 0.63)***
Cadaver	3.11 (0.94)	**0.42 (0.19, 0.65)****	2.77 (1.22)	0.31 (0.01, 0.62)	2.69 (1.10)	**0.47 (0.19, 0.74)***
Stoma	3.03 (0.87)	**0.33 (0.11, 0.55)***	2.56 (1.21)	0.33 (0.02, 0.63)	2.50 (1.10)	**0.47 (0.19, 0.74)***
Quit Guy	2.61 (1.02)	-0.06 (-0.34, 0.21)	2.19 (1.16)	-0.09 (-0.40, 0.22)	2.24 (1.13)	0.31 (0.00, 0.60)
Incubator (Baby)	3.17 (0.86)	0.13 (-0.09, 0.35)	2.44 (1.15)	0.23 (-0.08, 0.53)	2.61 (0.98)	**0.45 (0.20, 0.71)****
Secondhand Smoke (Baby)	3.03 (0.87)	0.13 (-0.10, 0.36)	2.44 (1.17)	0.16 (-0.15, 0.47)	2.55 (0.98)	**0.36 (0.10, 0.62)***
Secondhand Smoke (Woman)	2.82 (0.92)	0.15 (-0.09, 0.39)	2.28 (1.16)	-0.15 (-0.45, 0.16)	2.34 (1.00)	**0.36 (0.11, 0.61)***

***p < .05 **p < .01**

Note.
a: Adjusted for age, race/ethnicity, education, marital status, primary drug use and controlling for nesting of participants within clinics
b: Controlled for multiple comparison tests by the False Discovery Rate procedure

(adjusted mean ratings difference, women vs men = 0.22, 95% CI: 0.12, 0.33, p < .001), motivation to quit (adjusted mean ratings difference, women vs men = 0.21, 95% CI: 0.06, 0.35, p = .007), and negative emotions (adjusted mean ratings difference, women vs men = 0.38, 95% CI: 0.25, 0.52, p < .001). There was no difference between men and women on the message reactance measure (p = .359).

Comparisons of Responses to Each GWL by Sex

Table 4 presents results of comparisons by sex on each GWL for the ratings measures found significant in the analysis of overall ratings (credibility, motivation to quit, negative emotions). All analyses adjusted for age, race/ethnicity, education, marital status, primary drug, and accounted for nesting participants within clinic. There were statistically significant sex differences on ratings of credibility and negative emotions for some GWLs; all differences on both measures were in the direction of women rating the labels more strongly. Women rated 3 of 9 GWLs higher in credibility: "gum disease" (p < .009), "cadaver" (p = .009), and "stoma" (p = .019). Women rated 7 of 9 GWLs more strongly on negative emotions: "gum disease" (p = .014), "heart disease" (p= .041), "cadaver" (p = .011), "stoma" (p = .011), "incubator (baby)" (p = .009), "secondhand smoke (baby)" (p = .027), and "secondhand smoke (woman)" (p = .027). There were no statistically significant sex differences for any of the 9 GWLs on the motivation to quit measure.

DISCUSSION

Identifying effective GWLs for women, including those in the high-smoking population of individuals with additional SUDs, may contribute to the reduction of tobacco-related, health disparities for women. In the present study, we found no differences between male and female smokers in SUD treatment in ratings of images of women and/or babies versus other images. The research on responses to images of babies on GWLs in general samples of smokers is mixed; some have not shown sex-based differences,[23] although others have shown women

reporting personal relevance[34] and rating the images more strongly than men.[25,26,46] Numerous factors may contribute to different findings across studies, ranging from differences in participant samples (eg, smokers with SUDs vs general smoking samples) to variations in methods (eg, ratings measures, types of analyses conducted, such as comparisons of difference scores, as in our study).

Although women in our study did not respond differentially to images of women and/or babies versus other images relative to men's responses, they did have generally stronger reactions to GWLs. Women rated the GWLs overall as more credible, evoking more negative emotions, and higher in motivation to quit. They also rated 3 of 9 individual GWLs (ie, gum disease, cadaver, and person with a stoma) as more credible. These GWLs were 3 of the 4 labels rated highest in overall effectiveness according to Hammond et al.[47] It may be that higher perceived credibility of these messages among women was associated with overall label effectiveness. Additionally, women rated 7 of 9 GWLs higher in evoking negative emotions. The 2 labels with non-significant findings (lung disease, $p = .074$ and quit guy, $p = .086$) had the highest and lowest overall ratings respectively in our study, considering ratings of credibility, motivation to quit, and negative emotions, a finding also consistent with Hammond et al.[47] It may be that sex differences in negative emotions ratings hold for the middle range of overall effectiveness, but fail when GWLs are either highly effective or highly ineffective. Findings of increased negative emotional responses by women to most of the GWLs may be important. Emotional responses to GWLs have been associated with quit intention, quit attempts and reduced cigarette consumption.[36,48] Women have lower rates of successful smoking cessation and face sex-specific barriers to quitting ranging from fear of weight gain to more severe withdrawal symptoms.[49] Women with SUDs face additional barriers to smoking cessation, including cultural (eg, high prevalence and acceptability of smoking,) and neurobiological (eg, nicotine's modulation of neurotransmitter systems associated with rewarding effects of other substances).[50,51] It is likely that an array of interventions, including tobacco-regulatory and treatment innovations, will be necessary to reduce the sex disparities in sustained smoking cessation. Early evidence suggests that GWL exposure on cigarette packs may influence quit behavior in the population of smokers in SUD treatment.[15] Prospective, sex-specific studies of GWLs that include smoking behavior outcomes are necessary to determine whether strong emotional reactions to GWLs facilitate smoking cessation among women.

There were no sex differences in overall message reactance ratings in our study. Research shows that perceived efficacy to respond to fear-arousing messages is a variable which consistently affects message reactance.[52] We did not assess this in our study; thus, we cannot identify potential sex differences in perceived efficacy to address smoking and whether this would inform our message reactance finding. It is possible that this special population of smokers with poor rates of successful cessation[53] have low perceived efficacy for addressing smoking regardless of sex. Future studies should examine the effect of self-efficacy promoting messages accompanying GWLs, particularly in sub-populations of smokers with intractably low rates of cessation.[52,54]

Although women in our study had stronger overall ratings in motivation to quit, there were no sex differences on this measure for any individual GWL. A possible explanation is the decreased power available to detect differences associated with the smaller sample sizes for individual GWLs.

A growing body of research supports implementation of GWLs in the US.[7,55,56] Our findings indicate that GWLs with images of women, babies, and tobacco-related disease were impactful for women from a vulnerable population with high smoking rates and low rates of successful cessation. Findings support evidence that GWLs on cigarette packs are a population-level intervention that may be effective for diverse groups of smokers and may mitigate tobacco-related health disparities for women.[57] Directions for future research regarding the effectiveness for GWLs for women, particularly women in high smoking, vulnerable populations, include conducting controlled trials in which (1) smokers are exposed over time to GWLs on cigarette packages; (2) smoking, quit behavior, and sustained cessation outcomes are measured; and (3) outcomes are examined by sex, race/ethnicity, and co-morbidity with mental illness. Addition-

ally, research examining male versus female variants of specific GWL images (eg, depicting men vs women with tobacco-related disease) is necessary to determine whether sex of individuals depicted has differential sex-related effectiveness.

Limitations

Our study assessed sex differences in GWL ratings in a large sample of smokers who were engaged in SUD treatment. Although we know of no *a priori* reason why smokers participating in SUD treatment would respond differently to GWLs than other smokers, there may be group differences that affect responses to GWLs, thus limit generalizability of our findings. Potential moderating variables such as health literacy or education levels may differ between smokers with SUDs and those in the general population. Additionally, given evidence of impulsivity and delay discounting,[58] smokers with SUDs may be a group for whom anti-tobacco messages are less likely to facilitate behavior change despite immediate emotional reactions and quit motivation. Generalizability of results to other smokers with SUDs also may be limited. Participants in our sample of publicly funded programs within the CTN may differ from the population in for-profit treatment programs and programs outside the research network, as well as from the large number of individuals with SUDs who never obtain treatment.

We did not have information regarding mental health diagnoses for our sample. SUDs and mental illness are often co-morbid conditions and individuals in both groups smoke at higher rates than the general population.[51] As such, the potential impact of GWLs on the population of individuals with co-occurring disorders will be important to examine. We also did not ask participants whether they had children, an omission that precludes our ability to assess the potential relevance of women/baby images for parents versus non-parents or for mothers versus fathers. Given the public health significance of reducing smoking rates among pregnant women and mothers and given children of women with substance use disorders are already at increased risk for negative health consequences,[59,60] this is an important area of research for this population. A report in a general population sample suggests greater effectiveness of such images for women of child-bearing age than for other women or for men.[26]

Our ratings measured constructs commonly used in GWL research, but which may not provide a comprehensive assessment of message impact.[61] The 4 measures of GWL responses likely co-vary; however, we examined them separately to facilitate interpretation. We were interested in the first order question of whether men and women may respond differently to FDA-selected GWL labels. Other possible relationships, for example, whether negative emotional responses mediate motivation to quit responses, were not examined. GWLs varied across multiple dimensions, such as style of graphic presentation (eg, comic book vs realistic) and negative versus positive message framing, which have been shown to affect responses to GWLs.[25,47,62] Our study did not identify whether these dimensions may have contributed to our findings. It is possible that analyses of these dimensions would have informed our results regarding individual GWL ratings (eg, whether positive framing was a relevant variable in the non-significant, sex difference finding on negative emotion for the "quit" GWL). Finally, our participants rated GWLs based on a one-time exposure. We do not know whether findings generalize to real world conditions where smokers are regularly exposed to GWLs on cigarette packages.

IMPLICATIONS FOR TOBACCO REGULATION

The FDA has sought to strengthen evidence that GWLs reduce smoking prevalence. This should include investigation of GWLs with specific subpopulations who face tobacco-related disparities, such as women with additional SUDs, a group with high smoking rates resistant to smoking cessation. We found that female smokers in SUD treatment did not respond differentially to GWLs of women and/or babies but did rate GWLs more strongly overall than male smokers. Results support the use of graphic images including babies, women, and disease images, when developing warning labels for female smokers, including women with additional SUDs. Our findings contribute to the evidence base for implementation of GWLs on cigarette packaging in the US as one component of a comprehensive tobacco control policy that may reduce smoking cessation disparities.

Human Subjects Statement

The Institutional Review Board of the University of California, San Francisco approved procedures.

Conflict of Interest Statement

All authors of this article declare they have no conflicts of interest.

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