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Broadcast reach and self-reported exposure to court-ordered corrective statements on cigarette harms

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ABSTRACT

In August 2006, U.S. District Court Judge Gladys Kessler ordered four tobacco companies to disseminate court-approved corrective statements on five topics pertaining to health hazards of cigarette smoking. Based on the 2018 Health Information National Trends Survey (HINTS), approximately 50% of U.S. smokers viewed at least one corrective statement via television or newspaper during the first six months of the airings/publications (November 2017–April 2018). Using televised gross rating points (GRPs) and cross-sectional data from the 2018 HINTS ($n = 3484$) and 2019 HINTS ($n = 3331$), the current study extends previous ones by estimating broadcast reach/frequency and the moderating effect of survey year on smokers' exposure to a corrective statement. The weighted percentage of participants who viewed a corrective statement was significantly greater in the 2019 versus 2018 HINTS for smokers (64.3% vs. 50.5%, $\chi^2_{1df} = 5.85$, $p = .01$), but not for non-smokers (39% in 2018/2019, $\chi^2_{1df} = 0.02$; $p = .88$); this differential effect was evidenced by a significant interaction term ($OR = 2.0(1.2, 3.2)$, $p < .001$). This study also revealed that the televised reach of the corrective statements to the U.S. population (43.5 GRPs/43.5%) was comparable to the published estimate from the 2018 HINTS (40.6%). The frequency of exposure to any corrective statement in the first six months of televised airings was only 0.68 exposures/month, an estimate that does not meet CDC Best Practices. Yet, as evidenced by the significant interaction with survey year, it is likely that the addition of messages to tobacco company websites and cigarette package inserts may have contributed to smokers' greater exposure to a corrective statement.

1. Introduction

In September 1999, the U.S. Department of Justice filed a suit claiming that tobacco companies had violated the Racketeer Influenced and Corrupt Organizations Act (Farber et al., 2018) by deceiving the public about the health effects of cigarette smoking. In August 2006, U.S. District Court Judge Gladys Kessler ruled in favor of the Department of Justice and ordered four tobacco companies (Altria, R.J. Reynolds, Philip Morris USA, Lorillard) to disseminate court-approved corrective statements on five topics: 1) health hazards of smoking, 2) health hazards of exposure to second-hand smoke (SHS), 3) addictiveness of smoking and nicotine, 4) optimizing nicotine delivery through cigarette design, and 5) the fallacy of less harm from smoking “light”, “low tar”, “mild” or “natural” cigarettes (McCarthy, 2014; McCaffree and Desai, 2018).

Judge Kessler's lengthy opinion (1683 pages) addressed the deceptiveness of the tobacco industry and its effective use of marketing in promoting and normalizing cigarette smoking in society (Kessler,

2006). Judge Kessler argued that the industry continued to mislead consumers (Smokeless Tobacco and Health, 1970) for financial gain through its recruitment of new smokers (mostly adolescents) and prevention of cessation among existing smokers. No settlement prior to the Judge's ruling, including the 1998 Master Settlement Agreement (MSA), ever mandated tobacco companies to disseminate corrective statements (McCaffree and Desai, 2018; Guardino et al., 2007). Despite the landmark ruling in 2006, public health organizations expressed disappointment in both the exclusion of tobacco control initiatives (e.g., a national smoking cessation program (American Cancer Society, 2006)) and deletion of the terms “deliberately deceived the American public” and “This is the truth” from the corrective statements (McCaffree and Desai, 2018). As a result of the tobacco industry's appeals, it took 11 years before the corrective statements were finally published in the Sunday edition of newspapers (November 26, 2017–March 4, 2018) and broadcasted on network television (Monday–Thursday evenings) for one year, commencing on November 27, 2017.

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At least four experimental studies have evaluated corrective statements regarding smokers' quit intentions (Lee et al., 2019), increased knowledge about cigarette harms (Smith et al., 2011; Tangari et al., 2010), or perceptions about the statements (novelty, anger, etc.) (Kollath-Cattano et al., 2014). Smith et al. (2011) reported that approximately two-thirds of participants were unaware of the association between second-hand smoke exposure and heart disease at the study's baseline assessment. Exposure to each corrective statement yielded an improvement in knowledge, albeit a short-lived effect (< 1 week). Tangari et al. (2010) also reported an improvement in knowledge for each belief with exception of smoking addictiveness, which was due in part to ceiling effects. Lee et al. (2019) was the first to evaluate the actual court-ordered messages (i.e. not drafts/proposed versions), which significantly increased smokers' intentions to quit. Yet, the authors observed that participants who were exposed to messages enhanced with testimonials and statements about tobacco industry deception had an even greater intent to quit than those exposed to the original messages.

Three recent studies examined televised GRPs (Kostygina et al., 2019) and self-reported exposure (Blake et al., 2019; Chido-Amajuoyi et al., 2019) to the corrective statements. Kostygina et al. (2019) concluded that the first three months of the campaign generated little discussion on social media and insufficient exposure to impact smoking-related attitudes and behaviors, notably among adolescents (range of gross rating points (GRPs): 0.4–0.7). Using data from the 2018 HINTS, Chido-Amajuoyi et al. (2019) and Blake et al. (2019) also reported that some demographic groups (e.g., the less educated) were insufficiently exposed to the corrective statements. Current smokers, however, had a significantly greater odds of viewing the corrective statements than never smokers (OR range = 1.68–1.81). Chido-Amajuoyi et al. (2019) suggested that their findings could potentially inform the court-ordered implementation of corrective statements on tobacco industry websites (6/18/18 deadline) and cigarette packet onsets (i.e. leaflets; 11/21/18 deadline) (Cancer Action Network, 2018). The 2018 HINTS was administered to participants prior to the aforementioned deadlines, precluding the researchers' assessment of exposure to the corrective statements from the two additional sources.

The primary objective of the current study is to test whether survey year moderated smokers' exposure to a corrective statement as a likely function of the addition of corrective statements to tobacco company websites and cigarette pack onsets. A secondary objective of the study is to examine whether the published estimates of self-reported exposure to the corrective statements in the 2018 HINTS (Blake et al., 2019; Chido-Amajuoyi et al., 2019) are consistent with the statements' reach based on televised GRPs. GRP reach and self-reported exposure from the three recent studies cannot be directly compared because their respective time periods do not completely overlap. Kostygina et al. (2019) reported television GRPs and tweets for the months December 2017 and January 2018 (see Fig. 1, (Kostygina et al., 2019)), whereas, Chido-Amajuoyi et al. (2019) and Blake et al. (2019) reported exposure up until May 2, 2018. Assessing broadcast reach and self-reported exposure over the same time period facilitates examination of whether the two measurements are consistent with one another.

2. Materials and methods

2.1. Selection of participants

The Health Information National Trends Survey (HINTS) is regularly administered to a nationally representative sample of non-institutionalized, civilian adults (≥ 18 years) who reside in the United States. The HINTS 5 Cycle 2 (Westat, 2018) and HINTS 5 Cycle 3 (Westat, 2019) surveys were administered from January 26, 2018 to May 2, 2018 and January 22, 2019 to April 30, 2019, respectively. The two cross-sectional surveys are hence referred to as the 2018 and 2019 HINTS. Both entailed a two-stage sampling design that was very similar

with exception of the deletion of certain P.O. Box addresses from the sampling frame of the 2019 HINTS. The first of two stages of sampling entailed the stratification of residential households by a high and low proportion of racial/ethnic minorities (i.e. $\geq 34\%$ and $< 34\%$ of Hispanics and African-Americans, respectively), based on census tract characteristics from the American Community Survey (Westat, 2018). The second stage of sampling, which occurred within sampled households, entailed the selection of one adult whose next birthday was closest in calendar time. Participants of the 2018 and 2019 HINTS were administered a paper survey that was delivered to their household by U.S. mail. An additional Web Pilot was administered for assessing the feasibility of web-based data collection (Westat, 2019). Participants of the Web Pilot were excluded from the current study in an effort to eliminate any differences in 2018 and 2019 responses that may have occurred as a function of the survey format. The 2018 and 2019 HINTS (paper-only format) were combined as outlined in a technical document (Health Information National Trends Survey, 2020), yielding an analytical sample of 6815 participants.

2.2. Survey measures

Participants of the 2018 HINTS were initially asked if they had viewed any court-ordered corrective statement about cigarette harms in newspaper or television in the prior six months. Participants of the 2019 HINTS were asked a similar question, which differed with respect to the period of exposure (past 12 months) and an accompanying statement indicating that the messages had been disseminated by newspapers, television, tobacco company websites, and cigarette packs. Participants of the 2018 and 2019 surveys, who responded affirmatively, were subsequently asked if they had seen each of the five corrective statements in the following order: health effects of smoking, health effects of secondhand smoke, addictiveness of smoking/nicotine, cigarettes' enhancement of nicotine delivery, and harm from smoking low-tar/light cigarettes. Unlike the 2019 survey, the 2018 survey did not list tobacco company websites and cigarette pack onsets as sources of exposure.

Two prior analyses of the 2018 HINTS reported that among a host of variables in multivariable models, only smoking status and education were significantly associated with exposure to a corrective statement (Blake et al., 2019; Chido-Amajuoyi et al., 2019). It is possible that the dissemination of messages through tobacco company websites and cigarette packs could have reached a different demographic, justifying inclusion of the same demographic measures that were previously examined. Thus, independent variables in the current analysis were survey year, biological sex, age, race/ethnicity, highest grade completed, household income in the prior year, smoking status, and the interaction term survey year \times smoking status (see Table 2 for categories).

2.3. Gross rating points

The reach and frequency of the televised corrective statements were estimated using gross rating points (GRPs) from the Nielsen Company (Kostygina et al., 2019). The GRPs for each televised airing of an unspecified corrective statement was provided by television program and network over the period of exposure assessed in the 2018 HINTS (November 26, 2017–April 30, 2018). Our study did not assess GRPs through the remaining part of 2018 because exposure to corrective statements, reported by participants of the 2019 HINTS (past 12 months), may have occurred via tobacco company websites or cigarette pack onsets. The GRPs, which were derived from the Nielsen Company's National Market (not 210 Designated Market Areas), represent potential exposure or the opportunity to see (OTS) (Krugman et al., 2006) a corrective statement on cigarette harms. The GRPs are an aggregated metric consisting of audience reach \times frequency of potential exposure. Given this limitation, we attempted to differentiate reach

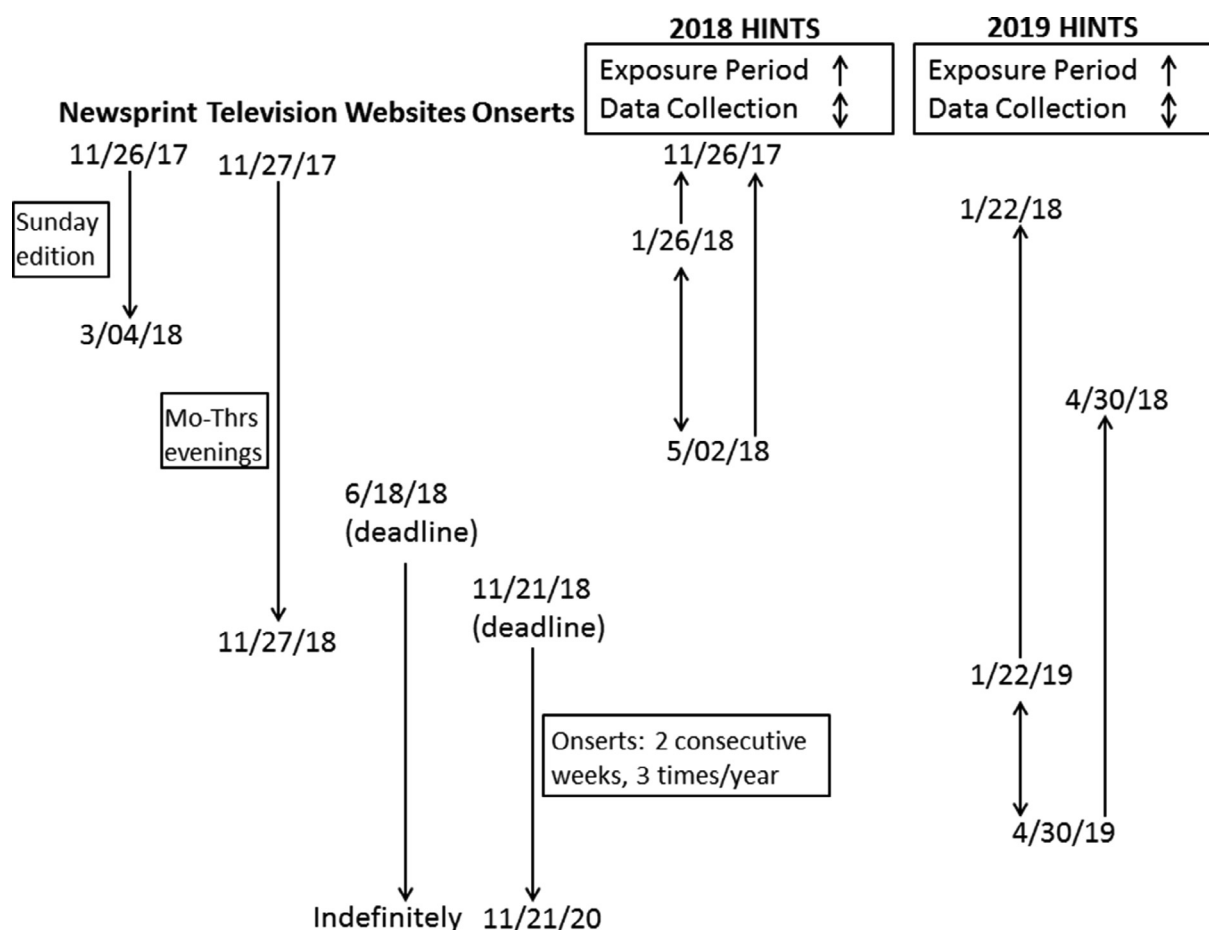


Fig. 1. Timeline of data collection of the 2018 and 2019 HINTS, periods and sources of exposure to corrective statements on cigarette harms.

from frequency using the following method. The GRPs of the corrective statements were first averaged for each television program ($N = 32$ programs) based on the assumption that a television viewer in a household can only watch one program at a time. The average GRPs were then summed across the 32 programs to yield the estimated reach. For example, a sum of averages equal to 35 GRPs (estimated reach) would indicate that 35% of television-viewing households were exposed to at least one television program with a corrective statement. Frequency was then calculated by dividing the grand total GRPs (i.e. all GRPs, not averages) by the estimated reach. Hence, the frequency estimate represents the average number of corrective statements viewed by U.S. households that were exposed to at least one corrective statement. In addition to the GRPs, expenditures for televised airings and newspaper advertisements, provided by Kantar Media, were examined in this study.

2.4. Statistical analyses

A bivariate analysis of exposure to a corrective statement and survey year (2018, 2019) was conducted for each demographic group using the Rao-Scott χ^2 test. Logistic regression models were then developed to test for associations between the independent variables and exposure to any corrective statement, each of the five corrective statements, and cumulative exposure as specified by a three-level, ordinal dependent variable (0, 1–3, 4–5 statements). The logit models included the interaction term smoking status \times survey year as an indirect means of testing whether the addition of corrective statements to tobacco company websites and cigarette packages moderated smokers' exposure to a corrective statement. All regression models, which were developed using proc surveylogistic in SAS v9.4, incorporated sampling

weights and the Taylor's Series method to account for the complex probability sampling of HINTS participants.

3. Results

3.1. Broadcast reach and frequency

The tobacco companies paid the television network CBS to broadcast the majority of corrective statements (75/111), which accounted for approximately two-thirds of the \$15.3 million spent on television expenditures (Table 1). The cost per GRP was very high for some programs (e.g., \$234,440 for Superstore), but lower for others (e.g., \$71,114 for Superior Donuts). The 45-second advertising spots, which were used for four of the five statements, accounted for 77.5% of all televised airings. The 30-second advertising spot on the addictiveness of smoking and nicotine accounted for the remaining airings (22.5%). The companies also spent \$7.02 million on 102 statements in 27 newspapers ranging from the Los Angeles Times to the Durham Herald Sun.

Estimates of the reach and frequency of communication of the five statements indicated that 43.5% of television-viewing households were exposed to an average of 3.5 statements (152.4 total GRPs/43.5 reach GRPs) from November 27, 2017 to April 30, 2018 (0.68 exposures/month). The GRPs provided by the Nielsen Company corresponded to exposure to corrective statements without specification of the five unique statements. We could, however, identify the GRPs corresponding to exposure to the statement on the addictiveness of smoking and nicotine, based on the message's 30-second duration versus the 45-second duration of the other four statements. Estimates of the reach and frequency of the statement on addictiveness of smoking and nicotine indicated that 19.0% of television-viewing households were exposed to

Table 1

Gross rating points (GRPs) and costs of advertising spots for corrective statements by television program and network (November 27, 2017–April 30, 2018).

Net-work	Television Program (Top 3 by network) ^a	No. ads	Cost (mill.) ^b	Gross Rating Points		
				Average	Total	Cost/GRP
CBS	Superior Donuts	16	\$1.679	1.475	23.603	\$71,114
	Man With A Plan	13	\$1.800	1.418	18.431	\$97,683
	Young Sheldon	8	\$1.668	1.777	14.217	\$117,163
	All CBS programs	75	\$10.163	$\Sigma^c = 19.446$	111.559	\$91,097
NBC	Superstore	4	\$0.678	0.723	2.892	\$234,440
	Better Late Than Never	4	\$0.403	1.474	5.897	\$68,340
	Blacklist	3	\$0.387	1.365	4.094	\$94,529
	All NBC programs	20	\$2.533	$\Sigma^c = 10.552$	22.290	\$113,638
ABC	Fresh Off The Boat	3	\$0.510	0.894	2.681	\$190,302
	Truth And Lies	2	\$0.448	1.676	3.351	\$133,721
	Bachelor Winter Games	2	\$0.301	0.772	1.543	\$194,945
	All ABC programs	16	\$2.645	$\Sigma^c = 13.536$	18.594	\$142,256
	All Network Programs	111	\$15.341	$\Sigma^c = 43.534$	152.443	\$100,633

^a First sorted on number of ads, and then sorted on cost in millions of dollars.^b Some variation in cost is attributed to duration of corrective statement (30 and 45 s ads).^c Sum of the average GRPs/program, an estimate of the broadcast reach of the corrective statements.

the statement 1.8 times (35.1 total GRPs/19.0 reach GRPs) from November 27, 2017 to April 30, 2018 (0.35 exposures/month).

3.2. Self-reported exposure to corrective statements

A slightly larger percentage of U.S. adults viewed a corrective statement during the one-year period prior to the 2019 HINTS (42.5%)

compared to those who viewed a statement during the six-months prior to the 2018 HINTS (40.6%) ($\chi^2_{1df} = 0.82$; $p = .36$). The bivariate analysis indicated that the only statistically significant association between exposure to any corrective statement and survey year occurred for current smokers (Table 2). The weighted percentage of participants who viewed a corrective statement was significantly greater in the 2019 versus 2018 HINTS for smokers (64.3% vs. 50.5%, $\chi^2_{1df} = 5.85$,

Table 2

Associations between demographic variables, smoking status and exposure to any corrective statement in the 2018 and 2019 HINTS (n = 6815).

Independent Variable	Total %	% Reported any corrective statement (std. error of %)			Adjusted OR ^b (95% C.I.)
		2018HINTS (n = 3,484)	2019HINTS (n = 3,331)	χ^2_{1df} ^a	
<i>Survey Year</i>		40.62 (1.48)	42.52 (1.48)	0.82	1.02 (0.85, 1.23) ^c
<i>Sex</i>					
Female	51.3	38.82 (1.46)	41.42 (1.68)	1.37	Referent
Male	48.7	42.53 (2.60)	43.68 (2.39)	0.11	1.13 (0.95, 1.33)
<i>Age Categories</i>					
18–29 years	15.9	40.28 (5.21)	47.75 (5.98)	0.88	Referent
30–49 years	33.4	38.99 (2.75)	37.00 (2.54)	0.29	0.67 (0.47, 0.96)*
50–64 years	30.7	42.99 (2.62)	45.06 (2.44)	0.33	0.90 (0.65, 1.25)
≥ 65 years	20.0	40.08 (1.96)	43.65 (1.72)	1.87	0.98 (0.71, 1.35)
<i>Race/Ethnicity</i>					
NH White	63.8	41.10 (1.95)	44.14 (1.65)	1.42	Referent
NH Black	11.9	40.68 (3.41)	44.41 (4.09)	0.49	1.18 (0.91, 1.54)
Hispanic	15.8	42.28 (3.70)	38.00 (3.49)	0.72	1.05 (0.81, 1.37)
NH Other	8.4	33.79 (5.78)	36.15 (5.77)	0.08	0.79 (0.55, 1.15)
<i>Highest Grade</i>					
< 12 years of education	8.2	34.14 (4.41)	41.49 (5.74)	1.09	Referent
12 years/H.S. diploma	23.2	35.11 (2.91)	40.03 (3.17)	1.30	0.99 (0.67, 1.47)
Some college/technical ^d	39.5	44.30 (2.86)	44.56 (2.51)	0.005	1.35 (0.92, 1.99)
≥ college graduate	29.1	41.87 (1.67)	42.07 (2.06)	0.006	1.18 (0.81, 1.73)
<i>Household Income</i>					
< \$20,000	18.6	34.87 (3.56)	36.89 (3.63)	0.16	Referent
\$20,000–\$49,999	24.4	40.12 (2.53)	40.58 (3.06)	0.01	1.35 (1.03, 1.78)*
\$50,000–\$74,999	18.0	38.66 (4.17)	42.28 (3.40)	0.45	1.38 (0.98, 1.93)
≥ \$75,000	39.0	44.02 (2.00)	47.50 (2.18)	1.39	1.86 (1.37, 2.52) [†]
<i>Smoking Status</i>					
Never/Former smoker	85.9	39.13 (1.53)	39.46 (1.63)	0.02	Referent
Current smoker	14.1	50.52 (4.46)	64.26 (3.68)	5.85*	1.73 (1.19, 2.51) [‡]
<i>Interaction Term</i>					
Smoking Status × Survey Year		Crude OR ^c : 1.74 (1.05, 2.89)*			1.96 (1.18, 3.23) [‡]

* $p < .05$; [†] $p < .01$; [‡] $p < .001$.^a Rao-Scott chi-square test of the association between exposure to a corrective statement (yes/no) and survey year (2018/2019) for the given demographic.^b Odds ratios in the multivariable logistic regression model.^c Reference is 2018 HINTS.^d Attended technical or vocational school.^e OR corresponding to interaction term in a model with the main effects smoking status and survey year.

Table 3

Associations between current smoking and recall of exposure to five court-ordered corrective statements in the 2018 and 2019 HINTS.

Corrective Message	% Reported corrective message (std. error of %)				Adjusted OR ^b (95% C.I.) Main effects only	
	Total %	2018 HINTS	2019 HINTS	$\chi^2_{(1df^g)}$		
<i>Health effects of smoking</i>	34.8					
Never/Formers smokers		32.86 (1.45)	32.86 (1.59)	0	Referent	
Current smokers		44.24 (4.30)	50.15 (3.85)	1.06	2.08 (1.61, 2.69) [†]	
<i>Health effects of SHS^c</i>	26.6					
Never/Formers smokers		24.36 (1.43)	25.42 (1.33)	0.29	Referent	
Current smokers		38.07 (4.34)	35.32 (3.35)	0.25	1.92 (1.49, 2.49) [†]	
<i>Nicotine Addictiveness^d</i>	22.4					
Never/Formers smokers		20.41 (1.13)	21.03 (1.16)	0.15	Referent	
Current smokers		31.01 (3.65)	34.41 (3.25)	0.49	2.19 (1.70, 2.82) [†]	
<i>Low-tar/light cigarettes^e</i>	14.0					
Never/Formers smokers		12.25 (0.76)	11.99 (0.75)	0.06	Referent	
Current smokers		27.13 (3.69)	22.60 (3.01)	0.91	2.63 (1.99, 3.48) [†]	
<i>Design of cigarettes^f</i>	10.1					
Never/Formers smokers		10.03 (1.21)	8.56 (0.65)	1.24	Referent	
Current smokers		17.82 (2.85)	11.48 (1.98)	3.48	1.97 (1.43, 2.71) [†]	
	2018 HINTS		2019 HINTS			
<i>Number of messages (0–5)</i>	Q50 ^g	Q75	Q90	Q50	Q75	Q90
Total Population	0	2	4	0	2	4
Never/former smokers	0	2	3	0	2	3
Current smokers	1	3	5	1	3	4
						Referent
						2.39(1.87, 3.05) ^{†,h}

[†] $p < .001$.^a Rao-Scott chi-square test of the association between exposure to each corrective message (yes/no) and survey year (2018/2019), by smoking status.^b Odds ratio from multivariable logistic regression models, which include covariates in Table 2, but exclude the interaction term smoking status \times survey year (sample sizes range from 6446 to 6473).^c Secondhand smoke.^d Addictiveness of smoking and nicotine.^e Low-tar/light cigarettes are as harmful as conventional cigarettes.^f Cigarettes are designed to enhance delivery of nicotine.^g Weighted quantiles (%).^h Estimate was derived from a proportional odds model (see Methods).

$p = .01$), but not for non-smokers (39% in both periods, $\chi^2_{1df} = 0.02$; $p = .88$). Examining subgroups of non-smokers indicated that exposure to a corrective statement did not differ significantly between the 2018 and 2019 surveys for either never smokers (38.6% vs. 36.8%, $\chi^2_{1df} = 0.40$, $p = .53$) or former smokers (40.6% vs. 46.5%, $\chi^2_{1df} = 2.37$, $p = .12$). The moderating effect of survey year on exposure to a corrective statement in smokers versus non-smokers (never/former) was evidenced by a statistically significant interaction term in univariate and multivariable regression models (see Table 2).

The self-reported exposure to each of the five corrective statements did not differ significantly between the two survey years for smokers, non-smokers, or any other group (see Table 3). Further, the interaction term smoking status \times survey year was not statistically significant in any of the five models (*data not shown*). No difference was observed between the two survey years for the cumulative exposure to the five messages (0–5), as evidenced by similar distributions (i.e. quantiles) and a non-significant regression estimate for survey year in the proportional odds model (OR = 1.08(0.92,1.27), $p = .35$). Similar to the estimates published by Blake et al. (2019), data combined from the 2018 and 2019 HINTS indicated that U.S. adults' exposure to the individual corrective statements ranged from a high of 34.8% (health effects of smoking) to a low of 10.1% (cigarettes designed to enhance nicotine delivery). Our findings also indicated that smokers had significantly greater odds than non-smokers of being exposed to each of the five corrective statements. Based on data from the 2018 HINTS, 22% of U.S. adults viewed the corrective statement on the addictiveness of smoking and nicotine, which is similar to the estimated reach of the televised airings (19.0 GRPs or 19%).

4. Discussion

The moderating effect of survey year on smokers' exposure to a

corrective statement is likely due in part to the addition of corrective statements to tobacco company websites and cigarette pack inserts. The significant interaction was anticipated as the two sources of direct marketing have been used by the tobacco companies to reach tobacco consumers. The website Marlboro.com, for example, is visited by one million tobacco users per month (Ilakkuvan et al., 2014). Less is known about the reach and impact of cigarette pack inserts, which have been used in recent years for promoting tobacco products and corporate responsibility (Apollonio and Glantz, 2019). Apollonio and Glantz (2019) reported that for a limited time in the year 2002, Philip Morris voluntarily added inserts to its cigarette packs containing health warnings about smoking "light" cigarettes. It is estimated that the inserts reached 86% of adult smokers who purchased the company's cigarettes. Based on this estimate, it is likely that many daily smokers who participated in the 2019 HINTS were exposed to the inserts because federal court had mandated them by November 21, 2018. Yet, the smokers who purchase cigarettes in bulk may not have viewed the inserts because cigarette packs contain the corrective statements for only two consecutive weeks at three different times of the year (Cancer Action Network, 2018).

Despite reaching almost two-thirds of U.S. smokers, there are at least three arguments why the corrective statements might have had a negligible effect on smoking behavior (Kostygina et al., 2019; Apollonio and Glantz, 2019; Vallone et al., 2011). The first relates to the lack of emotionally evocative content of the corrective statements. Vallone et al. (2011) reported that, in contrast to information-based content, exposure to emotionally evocative content was more strongly associated with quitting smoking. The second argument is the low frequency of exposure to the televised airings (0.68 exposures/month), which exceeds the estimate of 0.56 exposures/month reported by Kostygina et al. (2019). The difference in estimates may be partly attributed to our distinction between reach and frequency of exposure, the latter of which was estimated for households that viewed at least

one corrective statement. Irrespective of any methodological differences between Kostygina et al. (2019) and our group, the two estimates indicate that exposure to a corrective statement falls short of the Center for Disease Controls' (CDC) Best Practices of 10–12 exposures/4 months (Emery et al., 2012). The third argument for a negligible effect on smoking behavior pertains to the display of the five corrective statements on the tobacco company websites and cigarette pack inserts. The Corporate Responsibility group of Philip Morris concluded in 2007 that cigarette pack inserts containing repeated messages are ineffective and often ignored (Apollonio and Glantz, 2019). In the current study, neither smokers nor non-smokers differed significantly in their cumulative exposure to the corrective messages (0–5) in the 2018 and 2019 HINTS. This finding was unexpected because unlike the televised airings of single messages, tobacco company websites display all five corrective messages. It is plausible that many smokers perused the statements without carefully contemplating each individual message.

4.1. Study strengths and limitations

Our study benefited from the use of gross rating points (GRPs) and survey data to estimate the reach and frequency of exposure to the corrective statements. Further, the surveys were taken at times when corrective statements were first disseminated through television and newspapers (2018 HINTS), and then disseminated through websites and inserts (2019 HINTS). Yet, the use of cross-sectional surveys, which did not query participants about each individual source of exposure, precluded us from determining whether the interaction between survey year and smoking status was due to the addition of corrective statements to websites and inserts, or some other factor such as smokers' greater recall of statements over time. Based on data from the 2018 HINTS, Chido-Amajuoyi et al. (2019) reported that exposure to a corrective statement increased with the period of exposure for current smokers (46.6–78.3%) and former smokers (40.5–48.2%), but not for never smokers (40.9–38.9%) (Chido-Amajuoyi et al., 2019). These figures, which follow a pattern similar to our 2018–2019 estimates, challenge the interpretation that websites and inserts were main contributors to smokers' increased exposure to the corrective statements. Yet, small sample sizes and the brief period of exposure in the analysis by Chido-Amajuoyi et al. (2019) need to be considered in interpreting temporal exposure differences between smokers and non-smokers.

The use of additional measures, such as website traffic and cigarette purchases via consumer panels, could have helped distinguish the two most recent sources of smokers' exposure to the corrective statements. Such an examination was beyond the scope of this study. The acquisition of GRPs for the exposure period corresponding to the 2019 HINTS would not have benefited our study because the Nielsen Company provides GRPs neither for inserts/websites, nor television viewership by smoking status. An additional limitation was the absence of a measure of reach and frequency of newspapers that published the corrective statements. Yet, it is likely that the newspapers would have had a negligible effect on exposure because based on data from the 2015 HINTS-FDA (*analysis not shown*), only 2.4% of the U.S. population read the newspaper, but did not watch television during weekdays (i.e. when statements were broadcasted). Further, the period of exposure for some participants of the 2019 HINTS did not include the dates when newspapers published the corrective statements (see Fig. 1).

4.2. Conclusions

Our estimates of broadcast reach/frequency from the televised GRPs, which are consistent with survey data (2018 HINTS), suggest that the low frequency of exposure to the corrective statements may have a minimal effect on changing smoking behavior. However, the interaction observed in this study for survey year is promising because the corrective statements, which are intended to inform smokers about the true hazards associated with smoking behavior, appear to be

increasingly reaching the target audience. The question of whether the increase can be attributed to dissemination of corrective statements via tobacco websites and cigarette pack inserts, or smokers' greater recollection of the statements over time, cannot be determined from the data. But, it is likely that the former is contributing to the increase because the tobacco websites and cigarette pack inserts are being used by tobacco companies to market their products directly to tobacco consumers. The websites and inserts are the only sources of corrective statements henceforth because newspapers and television discontinued carrying the statements in March 2018 and November 2018, respectively. Yet, it is unclear if dissemination of the messages through the inserts, which end in November 2020, and websites (indefinite) will have a lasting impact on smoking behavior.

Conflict of interest statement

The authors declare that there is no conflict of interest with the publication of these findings.

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Credit authorship contribution statement

David S. Timberlake: Conceptualization, Methodology, Data curation, Software, Validation, Formal analysis, Writing - original draft. **Cornelia Pechmann:** Conceptualization, Methodology, Writing - review & editing.

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