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Believability of messaging concerning a hypothetical product standard to lower a constituent in cigarettes or smokeless tobacco among U.S. Adults who use tobacco

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ABSTRACT

The U.S. Food and Drug Administration (FDA) has regulatory authority to implement tobacco product standards to reduce harmful and potentially harmful constituents (HPHCs). This study examines people who use tobacco products' awareness of FDA's tobacco regulatory authority, knowledge of HPHCs, and belief in hypothetical tobacco product standard statements. We recruited adults who reported currently using tobacco (N = 1,592) from the National Panel of Tobacco Consumer Studies and randomized them to one of four conditions. Participants viewed a stimulus which consisted of a statement about a hypothetical product standard that would reduce the level of a chemical in cigarettes or smokeless tobacco (ST) and reduce cases of cancer or heart attack and stroke. A small majority of participants correctly believed that FDA regulates tobacco; however, the percentage of participants who recognized HPHCs varied widely depending upon the chemical. People who currently use ST found chemical and health statements more believable than people who did not currently use ST. Participants found it more believable that cigarettes, not ST, could be made with fewer harm-causing chemicals, and their belief in the chemical and health statements did not differ based on the health outcome specified in the hypothetical product standard statement.

1. Introduction

Cigarettes and smokeless tobacco (ST) products contain thousands of chemicals, some of which increase users' risk of cancer, cardiovascular and metabolic diseases, and pulmonary diseases (National Cancer Institute and Centers for Disease Control and Prevention, 14AD; U.S. Department of Health and Human Services, 2010National Cancer Institute and Centers for Disease Control and Prevention, 14AD; U.S. Department of Health and Human Services, 2010; U.S. Department of Health and Human Services, 2014). Under the Family Smoking Prevention and Tobacco Control Act (Tobacco Control Act), the Food and Drug Administration (FDA) has the regulatory authority to implement standards for tobacco products. FDA can develop product standards to reduce harmful and potentially harmful constituents (HPHCs) (Ashley et al., 2014) and has announced intentions to develop a product standard to lower nicotine yields (U.S. Food and Drug Administration, 2018). Per the Tobacco Control Act, tobacco product standards must be appropriate for the protection of the public health. To determine whether a product standard is appropriate for the protection of the public health, FDA must consider the risks and benefits of the proposed standard to the population as a whole, including users and nonusers of tobacco products, the likelihood that existing users will stop using such products, and the likelihood that those who do not use tobacco products will start using such products.

Individuals' decisions to stop or start using a tobacco product are shaped in part by their beliefs about the product (Krosnick et al., 2006; Pepper and Brewer, 2014). For instance, people who smoke cigarettes report higher odds of planning to quit smoking as their awareness of the numbers of chemicals in cigarette smoke increases (Hammond et al., 2006) but many adolescents and adults are unaware of a number of chemicals in cigarette smoke (Brewer et al., 2016). Judgments about the harmfulness of a tobacco product are based, in part, on beliefs about what is in the product (Kozlowski et al., 1998; Shiffman et al., 2001). Therefore, if communicated, the reduction or removal of a harmful

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chemical from a tobacco product may influence tobacco risk perceptions, and ultimately, tobacco use behavior. For example, among people who smoke cigarettes, those who believed that it is possible to make tobacco products without some harmful chemicals had greater interest in using hypothetical modified risk tobacco products that are less addictive and hypothetical modified risk tobacco products that are less harmful than other tobacco products (O'Brien et al., 2018). Additionally, awareness of FDA's regulatory authority over tobacco products may positively influence the extent to which consumers believe product standard statements. Despite low consumer awareness of FDA regulatory authority over tobacco (Fix et al., 2011; Jarman et al., 2017; Kaufman et al., 2015; Nguyen et al., 2018), most consumers believe that FDA can effectively regulate tobacco products (Boynton et al., 2016). Therefore, if consumers are aware of FDA's regulatory authority over tobacco, they may find product standard statements credible and believable.

Recognizing the importance of the credibility and believability of product standard messaging, we examined people who use tobacco's awareness of FDA authority and beliefs about hypothetical product standards that would reduce a chemical in cigarettes or ST and reduce the incidence of cancer or heart attack and stroke, as communicated via a short statement. The purpose of this research was to examine how perceptions about a product standard statement vary by the product type and health outcome described in the product standard statement.

2. Methods

2.1. Participants and procedure

From August 27, 2020 to November 11, 2020, we recruited participants through the National Panel of Tobacco Consumer Studies (TCS), a probability-based panel of adults who use tobacco who agreed to participate in up to eight experimental and observational studies over a 3-year period (Krotki et al., 2019). The TCS panel was initially recruited in 2017 and replenished in 2019 (Liu et al., 2022). We contacted potential participants via email, mail, or automated telephone or text messaging, according to their preference. Overall, we invited 3,458 panel members to participate; 1,943 participants (n = 1,592 web; n = 351 mail) completed surveys for an unweighted response rate of 61.6%. There were significant demographic differences between web and mail mode participants ($p < 0.05$). Web mode participants tended to be younger, female, white, have greater educational attainment, have greater household income, and more likely to be current users of cigarettes, e-cigarettes, and hookah or waterpipe. Among users of each product type, web mode participants used cigar and ST fewer times in the past 30 days than mail mode participants. Only participants who completed the survey online were included in the experiment reported here as we could not ensure that mail mode participants completed the pre-test before viewing the experimental stimuli.

Our sample included adults (ages 18 and older) who reported currently using cigarettes, cigars, and/or ST (N = 1,592). We randomized participants to one of four study conditions using a 2x2 factorial design with factors of product type (cigarettes vs. ST) and health outcome (cancer vs. heart attack and stroke) that were manipulated in the hypothetical product standard statement that participants viewed. After completing a consent form, reporting their current tobacco use, awareness of FDA authority over tobacco products, and knowledge of HPHCs, participants read the following hypothetical product standard statement that varied based on their study condition: "FDA has required that tobacco manufacturers reduce the level of a chemical in all [Product Type: "cigarettes" or "smokeless tobacco products"]. This change will reduce the number of new cases of [Health Outcome: "cancer" or "heart attack and stroke"]." After reading the statement, participants answered questions about the believability of the hypothetical tobacco product standard statement. Participants took an average of 13.4 min to complete the online survey. After completing the survey, participants received an incentive per their agreement with the TCS: a total of $35 cash for completing both enrollment and baseline questionnaires of the panel. RTI's Institutional Review Board reviewed and approved the study methods and procedures before implementation (IRB ID: STUDY00021214).

2.2. Measures

2.2.1. Demographic information

We collected information on age, sex, race/ethnicity, educational attainment, and household income.

2.2.2. Tobacco use

Participants were classified as people who currently smoke cigarettes if they reported ever using cigarettes, had smoked cigarettes on at least one of the past 30 days, and had smoked at least 100 cigarettes in their life. Participants were classified as people who currently smoke cigars if they reported ever smoking a cigar, little cigar, or cigarillo and had smoked a cigar, little cigar, or cigarillo on at least one of the past 30 days. Participants were classified as currently using ST if they reported ever using ST and reported using ST on at least one of the past 30 days. Participants were also asked whether they currently used e-cigarettes and hookah or waterpipe. However, people who reported using e-cigarettes and hookah or waterpipe are only represented in this analysis if they also reported using cigarettes, cigars, or ST.

2.2.3. Awareness of FDA's regulatory authority

To assess participants' awareness of FDA's authority to regulate tobacco products, we adapted a measure from the 2015 Health Information National Trends Survey (HINTS) (Peterson et al., 2019; National Institutes of Health, 2015) that asked participants, "Who do you believe regulates tobacco products in the U.S.?" Participants selected all who they thought applied from a list of six entities (Centers for Disease Control and Prevention, Federal Trade Commission, FDA, National Institutes of Health, Surgeon General, and tobacco industry/companies) or selected "None of the above." We also asked participants, "Has the government put rules in place designed to make tobacco products less harmful?" (Fix et al., 2011) Participants could select "yes," "no," or "I don't know".

2.2.4. HPHC Awareness

We asked participants "Which, if any, of the following chemicals have you heard of?" Participants selected all that applied from the list of 20 HPHCs that FDA guidance recommends companies report (U.S. Food and Drug Administration Center for Tobacco Products, 2012) or "none of the above" (Hall et al., 2014).

2.2.5. Believability of chemical statement

We adapted an item from HINTS 2015 (National Institutes of Health, 2015) that asked participants "How believable is it that [Product Type] could be made with less chemicals that are harmful to health?" Response options ranged from 1 = not at all believable to 4 = very believable.

2.2.6. Believability of health statement

We adapted an item from HINTS 2015 (National Institutes of Health, 2015) that asked participants "How believable is it that reducing the level of a chemical in [Product Type] could reduce the number of new cases of [Health Outcome]?" Response options ranged from 1 = not at all believable to 4 = very believable.

2.3. Analysis

Based on a pre-specified statistical analysis plan, we examined sociodemographic and tobacco use characteristics, awareness of FDA's regulatory authority, and HPHC knowledge using descriptive statistics. We used two ordinal regression models to examine main and interaction

effects of Health Outcome, Product Type, cigarette use, and ST use on believability of the chemical statement and believability of the health statement. For Health Outcome, we coded the cancer condition as 1 and the heart attack or stroke condition as 0. For Product Type, we coded the cigarette condition as 1 and the ST condition as 0. We created two-way interaction terms for Health Outcome × Product Type, Health Outcome × cigarette use, Health Outcome × ST use, Product Type × cigarette use, and Product Type × ST use. We created three-way interaction terms for Health Outcome × Product Type × cigarette use and Health Outcome × Product Type × ST use. If an interaction term was nonsignificant (unadjusted p-value $\geq$ 0.05), we did not include the interaction term in the final model. Analyses used listwise deletion and unweighted data. We report unstandardized betas. In all analyses of the experimental data, we used the Benjamini-Hochberg procedure (Benjamini and Hochberg, 1995) to account for multiple comparisons. We assumed a False Discovery Rate of 0.05.

3. Results

3.1. Sample characteristics

Table 1 reports participants' sociodemographic and tobacco use characteristics organized by the assigned study condition (Health Outcome X Product Type). Mean number of days using e-cigarettes differed significantly between participants in the cigarette-cancer condition versus cigarette-heart attack and stroke condition. There were no other significant differences across study conditions.

3.2. Awareness of FDA's regulatory authority

When asked who regulates tobacco products, 57.2% of participants selected FDA from the list of options though only 25.1% correctly exclusively selected FDA. The next most-frequently selected responses (responses were non-exclusive) were the Surgeon General (39.1%); tobacco industry/tobacco companies (38.9%); Federal Trade Commission (16.5%); National Institutes of Health (13.1%); and Centers for Disease Control and Prevention (12.8%). Few (6.5%) participants selected "none

Table 1
Participant Sociodemographic and Tobacco Use Characteristics Overall and by Study Condition (N = 1,594).

Characteristic	Overall N (%) (N = 1,594)	Cancer Cigarettes (%) (N = 431)	Cancer Smokeless Tobacco (%)(N = 402)	Heart Attack and Stroke Cigarettes (%)(N = 409)	Heart Attack and Stroke Smokeless Tobacco (%)(N = 352)
Age (Mean)	44.0	43.5	44.5	44.5	43.6
Sex					
Female	759; 48	44.1	48.9	47.4	52.3
Male	814; 51.5	55.2	50.9	51.6	47.4
Other	9; 0.6	0.7	0.3	1.0	0.3
Race/Ethnicity					
White, non-Hispanic	1198; 75.7	75.8	75.4	75.7	76.0
Black, non-Hispanic	260; 16.4	16.2	16.3	17.4	15.7
Asian, non-Hispanic	21; 1.3	0.9	0.8	2.2	1.4
Native Hawaiian or Other Pacific Islander	8; 0.5	0.5	0.3	0.2	1.1
American Indian or Alaska Native	55; 3.5	4.7	3.8	2.2	3.1
Other or Multiple Race, non-Hispanic	83; 5.2	5.9	4.0	4.2	7.2
Hispanic	166; 10.5	11.3	10.3	8.8	11.7
Educational attainment					
Less than high school	75; 4.7	5.2	5.5	3.9	4.3
High school graduate or GED	479; 30.3	29.8	29.3	31.0	31.1
Some college/vocational school	481; 30.4	32.4	29.3	31.7	27.7
2-year college/vocational/ associate degree	237; 15	13.8	16.5	14.3	15.4
4-year college degree or higher	295; 18.5	18.1	18.0	17.7	21.1
Household income					
Under $30,000	486; 30.7	32.6	32.1	27.3	30.9
$30,000 to $49,999	321; 20.3	19.0	20.1	19.7	22.9
$50,000 to $74,999	235; 14.9	14.8	11.8	17.9	14.9
$75,000 to $99,999	163; 10.3	8.7	11.5	10.6	10.6
$100,000 or more	189; 11.9	15.0	12.6	11.8	7.7
Current cigarette use[a]	1156; 72.6	70.1	73.0	72.6	75.3
Current cigar, cigarillo, or little filtered cigar use[b]	426;26.8	26.9	27.8	24.2	28.4
Current smokeless tobacco use[b]	209; 13.1	11.8	13.3	13.0	14.8
Current e-cigarette use[b]	337; 21.2	21.4	20.3	21.0	22.2
Current hookah or waterpipe use[b]	75; 4.7	4.9	4.5	4.4	5.1
Current poly-tobacco use [c]	523; 32.8	31.3	32.8	32.0	35.5
Number of days smoking cigarettes in past 30 (Mean)[d]	25.6	25.7	25.7	25.7	25.4
Number of days smoking cigars in past 30 (Mean) [d]	10.08	11.0	9.93	9.77	9.51
Number of days using smokeless tobacco in past 30 (Mean)[d]	20.1	19.3	21.5	19.8	19.6
Number of days using e-cigarettes in past 30 (Mean)[d]	11.8	13.5	12.9	9.88	10.8
Number of days using hookah in past 30 (Mean)[d]	4.7	3.14	4.89	5.00	6.22

[a] Smoked at least 100 cigarettes in lifetime and smoked on one or more of the past 30 days.
[b] Used product on one or more of the past 30 days.
[c] Defined as using two or more products on one or more of the past 30 days.
[d] Among current users of tobacco product.

of the above." When asked whether the government has put rules in place designed to make tobacco products less harmful the most common response was "I don't know" (43.1% of participants), with the remaining participants almost equally split between "Yes" (27.0%) and "No" (29.8%).

3.3. Awareness of HPHCs

When asked to select chemicals that they had heard of, most participants selected nicotine (86.5%), carbon monoxide (82.4%), ammonia (76.1%), arsenic (68.3%), formaldehyde (61.4%), and benzene (51.4%). Fewer than half of participants indicated they had heard of the remaining 14 chemicals, and 7.4% indicated that they had not heard of any of the chemicals listed. See Table 2 for the percent of participants who reported having heard of each HPHC.

3.4. Believability of the chemical statement

Participants viewing the hypothetical cigarette product standard statement had higher odds of finding it believable that the product could be made with fewer chemicals (OR: 1.24; [95% CI: 1.04, 1.48]) compared to those who viewed the hypothetical ST product standard statement. In addition, adults who use ST had higher odds of finding it believable that cigarettes or ST could be made with fewer chemicals (OR: 1.50; [95% CI: 1.14, 1.97]) compared to adults who do not use ST. There were no effects by Health Outcome or current cigarette use. We found no significant interaction effects. Table 3 displays results of the ordinal logistic regression of the believability that a tobacco product (either cigarettes or ST, depending on study condition) could be made with less harmful chemicals. Supplemental Table 1 lists the unweighted proportions, means, and standard errors of believability of the chemical statement by condition and tobacco use status.

3.5. Believability of the health statement

Participants who currently used ST had higher odds of finding it believable that reducing the level of a chemical in either cigarettes or ST could reduce the number of new cases of a health outcome (OR: 1.42; [95% CI: 1.08, 1.86]) compared to participants who did not currently use ST. We found no significant interaction effects. Table 4 displays results of the ordinal logistic regression of the believability that reducing the level of a chemical in a tobacco product (either cigarettes or ST, depending on study condition) could reduce the number of new cases of a health outcome (either cancer or heart attack or stroke, depending on study condition). Supplemental Table 2 lists the unweighted proportions, means, and standard errors of the believability of the health statement by condition and tobacco use status.

Table 2
Percentage of Participants Reporting Having Heard of HPHCs in 2020 (N = 1,590).

HPHC	(%)
Nicotine (total)	86.5
Carbon monoxide	82.4
Ammonia	76.1
Arsenic	68.3
Formaldehyde	61.4
Benzene	51.4
Benzo[a]pyrene	30.1
Cadmium	28.2
Isoprene	25.7
Toluene	17.4
Acetaldehyde	17.1
1,3-Butadiene	9.9
Acrylonitrile	6.8
1-Aminonaphthalene	6.2
NNK (also known as 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone))	6.2
Acrolein	6.0
2-Aminonaphthalene	5.9
4-Aminobiphenyl	4.8
NNN (also known as N-nitrosonornicotine)	4.8
Crotonaldehyde	4.7
None of the above[a]	7.4

[a] Participants could select multiple options, except for "None of the above," which was mutually exclusive from other options.

Table 3
Ordinal Logistic Regression of Believability of the Chemical Statement Among Adult Participants Who Use Tobacco (N = 1,584).

Independent Variable	OR[e]	95% CI	p-value
Product Type: Cigarette[a]	1.24	1.04, 1.48	0.02**
Health Outcome: Cancer[b]	0.91	0.76, 1.09	0.31
Currently Smoke Cigarettes[c]	0.94	0.77, 1.16	0.58
Currently Use ST[d]	1.50	1.14, 1.97	<0.01**

[a] Referent = ST.
[b] Referent = Heart attack and stroke.
[c] Referent = Participants who do not currently smoke cigarettes.
[d] Referent = Participants who do not currently use ST.
[e] OR = odds ratio. CI = confidence interval. ST = smokeless tobacco.
** Significant after adjustment for multiple comparisons.

Table 4
Ordinal logistic regression of believability of the health statement among adult participants who use tobacco (N = 1,582).

Independent Variable	OR[e]	95% CI	p-value
Product Type: Cigarette[a]	1.13	0.95, 1.36	0.17
Health Outcome: Cancer[b]	0.86	0.72, 1.02	0.09
Currently Smoke Cigarettes[c]	1.02	0.83, 1.26	0.83
Currently Use ST[d]	1.42	1.08, 1.86	0.01**

[a] Referent = ST.
[b] Referent = Heart attack and stroke.
[c] Referent = Participants who do not currently smoke cigarettes.
[d] Referent = Participants who do not currently use ST.
[e] OR = odds ratio. CI = confidence interval. ST = smokeless tobacco. We dropped non-significant interaction terms from the model.
** Significant after adjustment for multiple comparisons.

4. Discussion

Our study revealed several important findings regarding awareness of FDA's regulatory authority over tobacco, awareness of HPHCs, and believability of hypothetical tobacco product standard statements among adults who use tobacco. Slightly over half of participants correctly responded that FDA is responsible for regulating tobacco. However, meaningful percentages of participants selected the Surgeon General (38.0%) and/or tobacco industry/tobacco companies (34.5%) in addition to FDA, suggesting confusion about who is responsible for regulating tobacco. Slightly less than half of participants responded "I don't know" when asked whether the government has put rules in place designed to make tobacco products less harmful, suggesting an area for future messaging. FDA announced in April 2021 it was "committing to advancing" product standards banning menthol cigarettes and all flavors, including menthol, in cigars (FDA, 2021). This announcement occurred after the data collection period for this study and therefore did not affect participants' responses. Research demonstrates that greater knowledge of FDA as a tobacco regulator is associated with higher perceptions of FDA's credibility (Schmidt et al., 2018). Without knowledge of who regulates tobacco products, consumers may distrust statements about reduced HPHCs in tobacco products as they may question the source and reliability of the statement (Weaver et al., 2017).

The percentage of participants who recognized HPHCs varied widely depending upon the chemical. Most participants were aware of nicotine,

followed closely by carbon monoxide and ammonia. Less than 10% of participants were aware of nine of the HPHCs; this finding aligns with other research indicating that one third or fewer of U.S. cigarette users are aware that cigarette smoke contains lead, mercury, or radioactive materials (Cummings et al., 2004; Siahpush et al., 2006). Our findings can inform HPHC education efforts by highlighting which HPHCs have the greatest "room to move" when it comes to awareness (Brennan et al., 2017; Hornik and Woolf, 1999). Many people who smoke cigarettes want to learn more about the HPHCs in cigarette smoke (Tobacco Control Network Writing Group should be listed as the final author. 2002 is the publication date). Furthermore, educating adults and adolescents about HPHCs, their health effects, and other products in which HPHCs are found (e.g., "this chemical is found in gasoline") discourages adults and adolescents from wanting to smoke cigarettes (Baig et al., 2017). The hypothetical product standard statements tested in this study linked a reduced level of an HPHC with reduced cases of a health outcome, which may discourage adults and adolescents from wanting to use tobacco products, a possibility that could be further explored. In a randomized controlled trial, participants' intentions to quit smoking increased after viewing statements about the chemicals in cigarette smoke, suggesting that information about HPHCs can influence behavior (Goldstein et al., 2021). However, it is still unclear how statements about reducing the amount of HPHCs in tobacco products would influence behavior.

Regardless of their own tobacco product use, participants found it more believable that cigarettes, not ST, could be made with fewer harm-causing chemicals. This finding could reflect the widespread misperception that additives (Baig et al., 2017; Morgan et al., 2017; Tobacco Control Network Writing Group should be listed as the final author. 2002 is the publication date) in cigarettes are the main source of harm when in fact chemicals produced by the combustion of tobacco and chemicals naturally found in the tobacco plant are the main source of harm (U.S. Department of Health and Human Services, 2010). The public may not hold the same misperception about additives in ST. Alternatively, participants may recognize that given combustion, cigarettes are more harmful than ST and thus believe that reducing harm-causing chemicals in cigarettes is more plausible than reducing harm-causing chemicals in ST.

Regardless of which hypothetical product standard statement they viewed, participants who use ST were more likely than those who did not use ST to believe the health and chemical statements. Participants who use ST may have found the health and chemical statements more believable given that the first products authorized to have modified risk claims were ST products and so they may be more familiar with statements about reduced risk (FDA, 2019). If this is the case, it suggests that if more information about reduced risk is communicated to the public, consumers may find that information more believable. This finding also highlights the importance of targeted communication based on product usage as not all people who use tobacco products have similar perceptions.

The extent to which participants believed the chemical and health statements did not differ based on the health outcome specified in the hypothetical product standard statement. The hypothetical product standard statements linked a reduction in the level of a chemical to a reduction in the number of new cases of heart attack and stroke or cancer. Viewing the hypothetical product standard statement with either health outcome (cancer or heart attack and stroke) may not have differentially impacted believability because all are top causes of death in the US (U.S. Department of Health and Human Services, 2021). It may also be that phrasing health outcomes as reducing the number of new cases is less impactful than other ways of describing health outcomes, such as numerically describing the risk of experiencing a health outcome, providing visual aids, providing both positive (e.g., survival rates) and negative frames (e.g., mortality rates), and characterizing risks using language specific to the individual (e.g., you, your) (Fischhoff et al., 2011).

Study results should be interpreted considering several limitations. First, our study used a "low dose" intervention where we briefly exposed participants to two sentences about a hypothetical product standard as part of an online survey. In the real world, information about product standards may be more comprehensive and exposure may be more frequent or longer lasting. Providing educational material with images and pictorials (e.g., of adverse health effects, representing text graphically) may increase the extent to which tobacco users find product standard statements believable. Second, research suggests that when viewing statements about reduced risks and exposure to chemicals, consumers want more specific information about risk reduction, including evidence (Wackowski et al., 2020). The hypothetical product standard statements used in this study did not specify which chemicals were reduced, what chemicals remained and what their harms could be, nor did they include evidence to support the chemical and health statements. Third, we only tested believability of hypothetical product standard statements among adults who used cigarettes, cigars, and ST. Some participants in each condition reported using e-cigarettes, and/or hookah. However, we did not examine whether dual use of these products differentially impacted product standard beliefs. People who use two or more tobacco products may have unique perceptions and beliefs that could impact their responses to a product standard statement. The hypothetical product standard was specific to cigarettes and ST; however, we included adults who only use cigars in analyses. We recognize the hypothetical product standard may have been less relevant to these participants. We also did not examine the responses of people who do not use any tobacco product to hypothetical product standard statements in this study.

FDA has the regulatory authority to implement standards for tobacco products. Consumers' responses to a tobacco product standard will in part be influenced by the extent to which they believe chemical and health effect statements. Findings may inform the development of education to improve public understanding of FDA's regulatory authority over tobacco products, bolster FDA's efforts to make tobacco products less harmful, and increase awareness of HPHCs in tobacco products. Such efforts may provide the baseline understanding necessary to increase the believability of chemical and health effect statements among consumers regardless of their tobacco use or the product type and health outcome specified in product standards.

Human subjects approval statement

RTI's Institutional Review Board reviewed and approved the study methods and procedures before implementation (IRB ID: STUDY00021214).

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Food and Drug Administration.

Authors' contributions

KAM, JKB, and ED conceptualized the project. KAM, JKB, ED, JKP, MEE, and JMN designed the experimental stimuli and questionnaire. JKP, MEE, and JMN conducted analyses. SJS prepared the manuscript. KAM, JKB, ED, JKP, MEE, and JMN provided feedback and edits during the manuscript preparation.

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CRediT authorship contribution statement

Samantha J. Venrick: Writing – original draft, Writing – review & editing, Formal analysis. **Katherine A. Margolis:** Conceptualization, Supervision, Writing – review & editing. **Jennifer K. Bernat:** Conceptualization, Supervision, Writing – review & editing. **Elisabeth Donaldson:** Conceptualization, Writing – review & editing. **Jessica K.**

Pepper: Investigation, Methodology, Project administration. **Matthew E. Eggers:** Formal analysis, Methodology. **James M. Nonnemaker:** Formal analysis, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102544.

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