



Aided recall of *The Real Cost* e-cigarette prevention advertisements among a nationally representative sample of adolescents

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ABSTRACT

E-cigarette use among youth remains a significant public health concern. In 2018, *The Real Cost* campaign began disseminating messages about the harms of vaping, primarily using digital media. We sought to determine the prevalence of aided recall of *The Real Cost* e-cigarette prevention ads and identify potential differences by participant characteristics. Participants were a nationally representative sample of adolescents living in United States (US) households recruited by the National Opinion Research Center (NORC) at the University of Chicago's AmeriSpeak panel in September and October of 2020. A total of 623 adolescents completed the survey. Analyses were weighted to represent the distribution of youth in the US, and effect sizes for individual characteristics were estimated using an adjusted marginalized two-part model. Seventy-one percent of adolescents recalled at least one of the five *The Real Cost* e-cigarette prevention ads, with individual ad recall ranging from a low of 38.8% (for *Magic*) to a high of 50.1% (for *Narrative*). Adjusted estimates of aided recall identified significantly higher recall among Black adolescents and those that used social media at medium or high frequencies ($p < 0.05$). Results support ongoing efforts by the FDA to reach youth with e-cigarette prevention messages using primarily digital media.

1. Introduction

E-cigarette use, also known as vaping, remains a significant public health concern among adolescents. The National Youth Tobacco Survey (NYTS) found that in 2020, 19.6% of high school students and 4.7% of middle school students had vaped in the last 30 days (Park-Lee et al., 2021). This is a decrease from use in 2019, where 27.5% of high school students and 10.5% of middle school students reported vaping in the last 30 days (Wang, 2019). The most recent data show that in 2021, 11.3% of high school students and 2.8% of middle school students vaped in the last 30 days (Park-Lee et al., 2021). The 2021 data are not comparable to the 2019 and 2020 data, however, because of methodological changes that were made to the NYTS during the COVID-19 pandemic. The decrease in use prior to the pandemic is promising, though given exposure to toxins like carcinogenic substances, and the risk of nicotine addiction (Centers for Disease Control and Prevention, 2019; Prochaska, 2019), vaping remains detrimental to the health of young people (National Academies of Sciences, Engineering, and Medicine, 2018),

bolstering increased efforts to dissuade youth from vaping.

Originally launched in 2014, *The Real Cost* is a youth-targeted campaign that seeks to educate young viewers, particularly those identified as being susceptible (having never used the referenced tobacco product, but open to using it in the future) or experimenters (having used the referenced tobacco product in the past), about the hidden dangers (or "real costs") of using tobacco products in an effort to curb tobacco initiation and use (Brennan et al., 2017; Duke et al., 2015). Campaign ads have been disseminated via television, online, radio, magazine, and cinematic ads, and later expanded to digital channels. Evaluations of *The Real Cost* cigarette smoking prevention campaign have shown high awareness and impact of the campaign (Delahanty et al., 2020; Duke et al., 2015; Huang et al., 2017), with increases in negative perceptions about smoking cigarettes among youth (Huang et al., 2017) and changes in cigarette smoking beliefs that were targeted by the campaign (Kranzler et al., 2017). Moreover, exposure to *The Real Cost* campaign ads was associated with a 30% decrease in the initiation of cigarette smoking among youth during the 3 year time period in

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which evaluation data were collected (Duke et al., 2019).

To address the rise in e-cigarette use among youth, in 2018, *The Real Cost* campaign began disseminating messages about the harms of vaping. Similar to smoking prevention ads, these e-cigarette prevention campaign ads target adolescents with messages about the negative effects of vaping, focusing on the negative impacts of nicotine on the brain and exposure to harmful chemicals. One change, however, is the use of teen-relevant digital media (e.g., social media, streaming services) as the primary method of dissemination for the e-cigarette prevention campaign ads. An overview of the campaign, as well as campaign visuals, can be viewed on the FDA's website (FDA, 2022, 2019), their YouTube page (The Real Cost, 2022), and in a recent content analysis of the campaign (Xuan and Choi, 2021). Detailed information about ad placement is not shared publicly by the FDA. However, the decision to focus on teen-relevant digital media (e.g., YouTube, Spotify, Pandora, Facebook, Instagram) was made intentionally by the FDA in attempts to avoid incidental exposure to adult smokers, who may benefit from switching completely to e-cigarettes (Zeller, 2019). Additionally, despite challenges such as the presence of misinformation and ever-changing content rules, social media channels show promise in increasing the reach and frequency of exposure to health messages (Stellefson et al., 2020), specifically among youth, with large frequencies of youth using Facebook (51%), Snapchat (69%), Instagram (72%), or YouTube (85%), and 89% reporting being online several times a day or almost constantly (Anderson and Jiang, 2018).

Because *The Real Cost* e-cigarette prevention campaign is relatively new, an examination of ad recall is needed to understand who has been exposed to the campaign. This is especially important given the novel digital nature of e-cigarette prevention campaign dissemination. Recent studies have examined exposure to *The Real Cost* campaign after the release of e-cigarette prevention ads among large samples from the National Youth Tobacco Survey (Mantey et al., 2021; Stevens et al., 2021). These studies revealed 63–77% recall, but they examined recall of *The Real Cost* for any tobacco products (as opposed to only e-cigarettes) and the surveys did not allow participants to view ad content. These studies also asked if participants had “seen or heard *The Real Cost*” in the last 12 months, a relatively long timeframe to recall exposure to the campaign (Mantey et al., 2021; Stevens et al., 2021).

While the above studies have shown promising results with regard to exposure to *The Real Cost* brand, assessment of aided recall of ads is needed in order to best characterize exposure to the *The Real Cost* national e-cigarette prevention campaign (Niederdeppe, 2014). As suggested by the Limited Capacity model of Motivated Mediated Message Processing (LC4MP), *unaided* recall confirms that a message has been encoded, stored, and can be freely retrieved from memory (Lang, 2000). However, this process requires a great deal of mental effort and could lead to underreporting of message exposure. In contrast, *aided* recall confirms that a message has been encoded and stored, and is prompted for retrieval using an aid, often visual in nature. It requires less cognitive effort and may improve recall assessment as individuals may recognize a component of a message to which they were previously exposed (Niederdeppe, 2014).

In the current study, we sought to estimate the frequency of aided recall of *The Real Cost* e-cigarette prevention ads and to identify potential differences by participant characteristics using a nationally representative sample of adolescents.

2. Methods

2.1. Participants and procedures

Participants were a national probability sample of US adolescents (ages 13–17) recruited in September and October of 2020 from the AmeriSpeak panel, a probability-based panel maintained by the National Opinion Research Center (NORC) at the University of Chicago in the US. NORC randomly selected US households using area probability

and address-based sampling, with a known, non-zero probability of selection from the NORC National Sample Frame. For the current study, adolescents were drawn from AmeriSpeak panel households. To address panel attrition due to the COVID-19 pandemic, NORC also invited adolescents ages 13–17 living in AmeriSpeak panel households who had not yet joined the teen panel to take part in the study. In total, 1,351 households had age-eligible children and received information about the study. Parents from 1,002 households (74% of those eligible) provided informed consent, and 624 adolescents assented and completed the survey (62% of households whose parents consented; 46% of all eligible households). One participant had extensive missing data and was excluded from analyses, resulting in $N = 623$. This study was approved by the University of North Carolina Institutional Review Board.

2.2. Measures

2.2.1. Tobacco product use status

Based on work on tobacco use susceptibility (Pierce et al., 1996; Strong et al., 2015), the survey assessed whether youth had vaped or smoked cigarettes in the past 30 days, and those who had were classified as a *current user*. If they had used the tobacco product before, but not in the past 30 days, we assessed whether they thought they would use the product in the future, on a 4-point scale ranging from definitely not (1) to definitely yes (4) (Pierce et al., 1996). If they answered anything other than ‘definitely not,’ we classified them as *at-risk* of vaping/smoking. For youth who had never used the tobacco product at all, the survey assessed whether they had ever been curious about using the tobacco product (Strong et al., 2015), and also if they thought they would use the tobacco product in the future (Pierce et al., 1996). If they answered anything other than ‘definitely not’ to both questions, we classified them as *at-risk* of vaping/smoking. We classified all other adolescents as *not-at-risk* of vaping/smoking.

We also assessed use of any other tobacco products and the presence of someone in the home who uses tobacco products. Other tobacco use was determined by asking “Which of these tobacco products have you used in the past 30 days?” Participants were asked to select all that apply from the following list of products: little cigars and cigarillos, traditional cigars, hookah, smokeless tobacco, pipe filled with tobacco, none of the above. Combustible cigarette use was assessed separately, with a similar item. Those who had used any of the tobacco products – including cigarettes – were categorized as using other tobacco products, compared to those who selected none of the above. We also asked participants to identify whether anyone who lives with the participant smokes cigarettes, cigars, cigarillos, or little cigars, uses chewing tobacco, snuff, or dip, uses e-cigarettes, and/or uses another form of tobacco. Those who selected any behavior(s) were categorized as having a someone who uses tobacco products in the home, compared to those who reported that no one who lives with them uses tobacco.

2.2.2. General recall of anti-vaping ads

To gauge general recall of anti-vaping ads, participants were asked about how often they had noticed “anti-vaping ads that discourage vaping” on television or online in the past three months. Responses were reported on a 5-point scale from never to very often.

2.2.3. General recall of pro-vaping ads

To gauge general recall of pro-vaping ads, participants were asked about how often they had noticed “ads or promotions that encourage vaping” on television or online in the past three months. Responses were reported on a 5-point scale from never to very often.







2.2.4. Aided recall

We assessed aided recall of a series of national *The Real Cost* e-cigarette prevention video ads that were publicly available within a six-month period prior to the launch of our national survey – i.e., March – August 2020. To our knowledge, ads were primarily placed in digital

channels, with some (e.g., *Epidemic*) airing on television at a later date. To assess recall, we asked participants, “Before today, how many times have you seen each of the following anti-vaping ads?” followed by a randomized list of the descriptions of each ad, which was accompanied by a collage of 4 still images from the ad (Table 1). We included a decoy ad in this list – developed by the study team – to assess potential recall bias.

Response options for aided recall were not at all, once, 2–4 times, 5–10 times, or 11 or more times, which were recoded into scores of 0, 1, 3, 7.5, and 11, respectively (Southwell et al., 2002). To create an ad recall index, participants’ ad recall across the five ads was averaged to yield a continuous score. Recall of the *decoy* ad was dichotomized as no recall (i.e., not at all) or any recall (i.e., once, 2–4 times, 5–10 times, or 11 or more times).

Table 1
Aided Recall of *The Real Cost* E-Cigarette Prevention Campaign by Advertisement.

Advertisement	Written Recall Aid	Visual Recall Aid	Aided Recall (Any), Weighted %
<i>Narrative</i>	Teenagers share their stories about negative experiences with vaping.		50.1%
<i>Epidemic</i>	A narrator describes harms of vaping while chemicals travel through teens’ bodies, causing physical changes to their appearance.		49.6%
<i>Metal monster</i>	A man talks about how vaping may deliver toxic metals into your lungs as a “metal monster” walks behind him.		46.1%
<i>Vapor</i>	Metal pieces fly through the air and turn into vapor coming from a vape that a teen is using.		42.4%
<i>Magic</i>	A street magician turns a vape into a cigarette.		38.8%
<i>Candy Store (Decoy)</i>	A teen dreams she is in a candy store, but screams in horror when her pile of candy turns into candy-flavored vapes.		19.5%

2.2.5. Demographics and social media use

Demographic characteristics included age, race (white, Black or African American, or another race), ethnicity (Hispanic, Latino, or Spanish), gender (female, male, nonbinary or other identity), highest parent education, household income, and sexual attraction (attracted to the opposite sex, same sex, or both sexes). Social media usage items asked about the frequency of use of five platforms (Facebook, Instagram, Twitter, Snapchat, and TikTok) on a 6-point-scale, ranging from never to almost constantly, which we averaged across platforms. Social media usage was categorized as low if the average score was less than 2, medium if the score was greater than or equal to 2 and less than 4, and high if the score was greater than or equal to 4.

2.3. Data analyses

We descriptively assessed the percentage of adolescents reporting recall of each of *The Real Cost* e-cigarette prevention advertisements and examined recall of any advertisement, stratified by participant characteristics. All categorical variables are reported by N (weighted %) and all continuous variables are reported by mean (standard deviation). Weights were calculated by NORC via a raking and re-raking ratio method to population totals for a general population of teens aged 13–17 associated with the following socio-demographic characteristics: age, sex, highest education of parent(s) in household, race, Hispanic ethnicity, and Census Division. Raking and re-raking were performed during the weighting process so that the weighted demographic distribution of the survey resembles the demographic distribution of the targeted population – teens aged 13–17 (Noar et al., 2021).

Due to the right-skewed, zero-inflated distribution of ad recall index, a marginalized two-part model (Smith et al., 2014) was fit to examine which individual-level characteristics are predictive of ad recall. Effect sizes for individual level characteristics were estimated using the marginalized two-part model and are reported along with 95% confidence intervals. T-tests were performed to test the null hypothesis that each level of an individual characteristic, as compared to the reference group, has an effect size of zero versus the alternative that they do not. Additionally, joint Wald tests were performed to assess the joint effects of covariates with more than two levels (including race, vaping status, social media usage, parent education, and income) on ad-recall. Participants were exposed to two smoking or vaping ads as part of the larger study. Due to possible confounding by varying exposure, analyses adjusted for exposure to the assigned ad (smoking or vaping) in the earlier experiment embedded in the survey (Noar et al., 2021). Analyses also adjusted for recall of the decoy advertisement (Niederdeppe, 2014).

Sensitivity analyses of the ad recall index were performed by recoding ad recall scores to the lower end of each interval (0, 1, 2, 5, 11) as well as to the upper end of each interval (0, 1, 4, 10, 25). Twenty-five was chosen as the higher end of the last category since it is reasonable to assume that few participants will have seen an individual ad more than 25 times. This recoding of ad recall scores to the lower and upper ends of each recall level interval resulted in no major changes from the primary analysis. Therefore, we used the mean recall score values as previously discussed.

A 0.05 type I error rate was applied with no adjustment for multiplicity. Complete case analyses were conducted and missing data were excluded. Analyses were conducted in Windows SAS version 9.4 (Cary, NC) and Windows R version 4.0.5.

2.4. Sample characteristics

A total of 623 adolescents completed the survey. Table 2 reports participant characteristics weighted to the population. About half were female (48.6%) and the average age was 15 (standard deviation [SD], 1.3). About 15.6% were current vapers, while 44.6% were at-risk of vaping and 39.8% were not at-risk of vaping. Less than 14.3% of the participants reported using other tobacco products and 37.0% reported

Table 2

Participant characteristics, N = 623.

Characteristics	N (weighted %)
Age (Years)	
Mean (SD)	15 (1.3)
Median (Range)	15.0 (13.0–17.0)
Race	
White	404 (66.8 %)
Black or African American	102 (15.4 %)
Some other race	117 (17.8 %)
Missing	0
Hispanic	
No	504 (75.1 %)
Yes	119 (24.9 %)
Missing	0
Gender	
Female	329 (48.6 %)
Male	269 (46.7 %)
Nonbinary or other identity	17 (3.7 %)
Missing	8 (1.1 %)
Vaping status	
Not at-risk of vaping	241 (39.8 %)
At-risk of vaping	293 (44.6 %)
Current vaper	89 (15.6 %)
Missing	0
Other tobacco use	
Yes	84 (14.3 %)
No	539 (85.7 %)
Missing	0
Home tobacco use	
Yes	222 (37.0 %)
No	387 (59.7 %)
Missing	14 (3.3 %)
Social media use	
Low	121 (21.4 %)
Medium	351 (53.7 %)
High	151 (24.9 %)
Missing	0
Highest parent education level	
High school or less	82 (23.2 %)
Some college with technical/vocational	236 (29.2 %)
Bachelor's degree	155 (23.7 %)
Graduate degree	150 (23.9 %)
Missing	0
Household income	
Less than \$50,000	245 (39.0 %)
\$50,000 to \$74,999	116 (16.5 %)
\$75,000 or more	262 (44.5 %)
Missing	0
Sexual attraction	
Attracted to Opposite Sex only	426 (67.8 %)
All Others	197 (32.2 %)

Note. SD = standard deviation.

having at least one tobacco product user in the home. About half (53.7%) reported medium social media use while the other half were split between low and high use.

2.5. General recall of Pro- and Anti-E-cigarette ads

Frequencies of general ad recall are presented in the supplemental Fig. 1. In general, participants reported seeing more anti-vaping ads than pro-vaping ads. The highest proportion (28.4%) of adolescents reported seeing anti-vaping ads sometimes, followed by rarely (24.2%), or never (19.8%). Fewer saw anti-vaping ads often (17.2%) or very often (10.4%). About half (51.5%) of the adolescents reported never seeing pro-vaping ads. Others saw pro-vaping ads rarely (27.8%), sometimes (13.5%), often (4.5%), or very often (2.8%).

2.6. Ad recall

Results indicate that 71% recalled at least one of the five *The Real Cost* e-cigarette prevention ads. Individual ad recall was 38.8% (*Magic*),

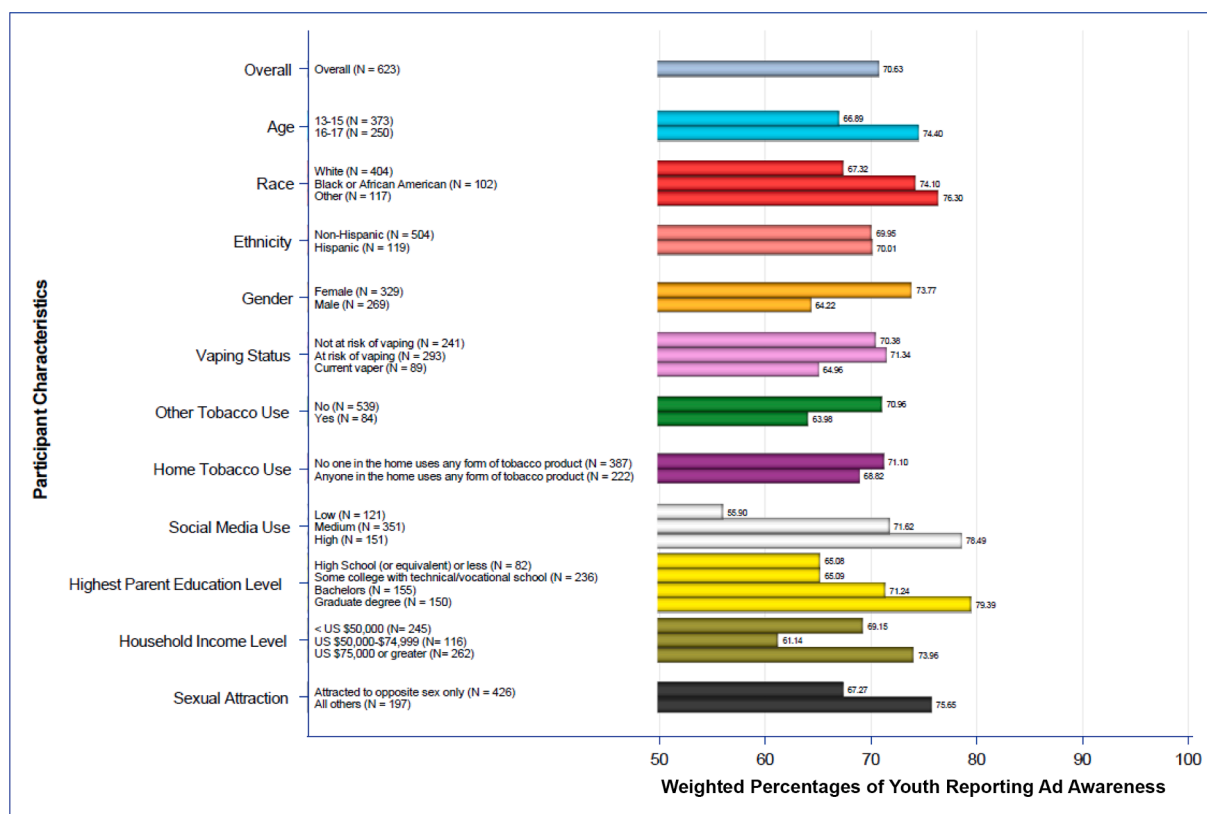


Fig. 1. Weighted Percentages of Adolescent Aided Recall of *The Real Cost* E-Cigarette Prevention Advertisements.

42.4% (*Vapor*), 46.1% (*Monster*), 49.6% (*Epidemic*), and 50.1% (*Narrative*; see Table 1). On average, adolescents recalled seeing 2.25 ads (SD = 1.90). Nineteen percent recalled all five *The Real Cost* e-cigarette prevention ads, 12.7% recalled four ads, 12.8% recalled three ads, 15.0% recalled two ads, 10.4% recalled one of the ads, and 29.4% recalled none of the ads. Nineteen percent of adolescents reported recall of the decoy ad.

Unadjusted aided recall (any vs none) by sample characteristics are presented in Fig. 1. These descriptive data show some variability in aided recall by participant characteristics, with 60 – 75% of subgroups recalling exposure to *The Real Cost* e-cigarette prevention ad(s). The group with the lowest recall of exposure were low social media users (55.9%) while the group with the highest recall of exposure were those whose parents had attained a graduate degree (79.4%).

Joint test results in Table 3 demonstrated that, overall, social media usage and parent education were significantly associated with ad recall (p-values 0.003 and 0.005, respectively). Adjusted estimates revealed that identifying as Black (versus white) and medium or high social media use (versus low use) were, on average, significantly associated with higher ad recall. Identifying as Black was associated with 1.48 (1.03, 2.12) times higher ad recall, on average, as compared to identifying as white. Those with medium social media use had, on average, 1.85 (1.29, 2.64) times higher ad recall than those with low social media use, while those with high social media use had, on average, 1.74 (1.15, 2.62) times higher ad recall than those with low social media use. All other characteristics were not statistically significant.

3. Discussion

The FDA-funded *The Real Cost* campaign aided in preventing upward of 587,000 youth from initiating cigarette smoking in a two year time-span between 2014 and 2016, alone (Duke et al., 2019). The inclusion of ads focused on e-cigarette prevention – and with a primary focus on digital channels – is relatively new and warrants exploration. We

assessed the prevalence of aided recall of *The Real Cost* e-cigarette prevention ads in a nationally representative sample and examined differences in recall on a variety of participant characteristics.

The majority (71%) of youth recalled ever seeing at least one of the ads, with over one-third reporting seeing each of the individual ads that we assessed. This frequency of recall is similar to assessments of aided recall of truth campaign e-cigarette prevention ads, where 74.2% had some awareness of the e-cigarette campaign (43.0% low awareness, 31.2% high awareness) (Hair et al., 2021). Recall was also similar to estimates from other nationally representative samples, despite these studies having used a more broad measure of recall of *The Real Cost* brand (between 63% (Mantey et al., 2021) and 77% (Stevens et al., 2021)). However, our results extend those prior studies by assessing exposure to a series of specific *The Real Cost* vaping prevention ads versus the general *The Real Cost* brand. In addition, while 71% exposure is promising, it is lower than the exposure achieved in *The Real Cost* cigarette smoking prevention campaign, which reached 89% of adolescents (Duke et al., 2015). This lower exposure could be the result of limited television placement of *The Real Cost* e-cigarette prevention ads, the novel nature of the original *The Real Cost* cigarette smoking campaign, or the method of assessment of *recognition* of the cigarette smoking prevention campaign, which showed adolescents actual video ads (Duke et al., 2019).

In addition, given that the primary dissemination method for e-cigarette-focused prevention ads was digital media, it was not surprising that more frequent use of social media was positively associated with higher recall of the ads, likely due to increased potential for exposure. This suggests that youth with lower social media use have less exposure to this campaign. However, social media use among youth is similar across a variety of demographic groups, with 95% having a smartphone and up to 85% using social media platforms (Anderson and Jiang, 2018). Furthermore, youth who use social media are more likely to be experimenters or current vapers (Lee et al., 2021), seemingly making them part of the FDA’s target population for the campaign. We, however, did

Table 3
Effect Sizes for Participant Characteristics on Aided Ad Recall Estimated Using the Marginalized Two-Part Model, n = 583.

	Estimate ^a	95% Confidence Limits		p-value ^b
		Lower	Upper	
Age (ref: 13–15)				
16–17	1.03	0.80	1.34	0.796
Race (ref: White)				0.054
Black or African American	1.48	1.03	2.12	0.036*
Some other race	0.88	0.63	1.22	0.447
Hispanic (ref: No)				0.066
Yes	1.34	0.98	1.82	0.066
Gender (ref: Male)				0.521
Female	1.09	0.84	1.40	0.521
Vaping Status (ref: Not at-risk of vaping)				0.218
At-risk of vaping	0.87	0.66	1.15	0.331
Current vaper	0.66	0.42	1.06	0.087
Other tobacco use (ref: No)				0.162
Yes	0.73	0.48	1.13	0.162
Home tobacco use (ref: No)				0.822
Yes	1.03	0.78	1.36	0.822
Social media use (ref: Low)				0.003
Medium	1.85	1.29	2.64	0.001*
High	1.74	1.15	2.62	0.008*
Highest parent education level (ref: High school or less)				0.005*
Some college with technical/vocational school	0.72	0.50	1.04	0.081
Bachelor's Degree	0.98	0.66	1.44	0.903
Graduate Degree	1.38	0.91	2.09	0.126
Household income (ref: Less than \$50,000)				0.606
\$50,000 to \$74,999	0.84	0.57	1.25	0.399
\$75,000 or more	0.87	0.64	1.19	0.387
Sexual attraction (ref: All other)				0.212
Only attracted to opposite sex	0.84	0.64	1.11	0.212

^aEstimates and confidence intervals were exponentiated to provide results interpretable in context; ^bP-values corresponding to overall, Type III tests are presented in the header of each row. P-values corresponding to tests of individual levels vs. reference level are presented next to corresponding levels; *Denotes p<0.05; Note. Model also adjusts for reported recall of the decoy ad (ever vs never: 1.89; 95% CI: 1.43, 2.50; p<0.05 and experimental ad condition from the larger study, vaping vs smoking: 1.02; 95% CI: 0.80, 1.29; p = 0.902).

not see an association between vaping status and ad recall. Findings, in combination with previous literature (Lee et al., 2021) point to associations between social media use, e-cigarette prevention ad recall, and vaping status that warrant further exploration.

While this is the first assessment, to our knowledge, of aided recall of *The Real Cost* e-cigarette prevention campaign, there have been prior assessments of recall of *The Real Cost* campaign. Previous studies found that recall of *The Real Cost* campaign ads significantly varied by tobacco product use (higher among youth who use tobacco products (Mantey et al., 2021), lower among youth who use tobacco products (Stevens et al., 2021), the presence of a tobacco product user in the home (higher) (Duke et al., 2019), and attraction to people of the same sex (higher) (Weiger et al., 2020). Notably, these are populations with disproportionately higher use of tobacco products (Li et al., 2021). While it is possible that recall was higher among subgroups in these studies because they were more likely to notice or remember the tobacco ads, being that they were more relevant to them, we did not see the same trend in our study. Instead, our findings suggest fairly consistent recall of the e-cigarette prevention ads across tobacco-related and most demographic characteristics. Differences in recall existed, though *The Real Cost* e-cigarette prevention campaign seems to reach a variety of youth with its primarily digital dissemination channel strategy.

There were also notable differences by race. Specifically, Black youth were more likely to recall ads compared to white youth. This finding is

contrary to other assessments of *The Real Cost* campaign recall, which identified higher levels of recall among white youth (Mantey et al., 2021; Stevens et al., 2021; Weiger et al., 2020). The reason for increased recall among Black youth is unclear, as it may be influenced by the demographic diversity of characters in the ads, the primary use of digital media for ad placement, or other factors. Future research should seek to identify factors that influence recall among Black youth, as findings may aid future communication efforts with this population.

Limitations should be considered when drawing conclusions from the current study. There is no “gold standard” measure of ad recall, and all ad recall measures are subject to self-report bias (e.g., under/over reporting). We adapted a measure used by Southwell et al. (2002) from a prior national anti-drug media campaign. Also, we did not show participants the video ads but rather written descriptions with a collage of images from the ad, to assess aided recall. In addition, similar to prior studies, we found a modest proportion of the sample reported exposure to a decoy ad that does not exist, exemplifying possible over-reporting of ad exposure. The ads were also released at various points in time, and with different media weights, affecting the opportunities that youth had to be exposed to them prior to the study.

Despite these limitations, this study had a number of strengths. First, analyses were conducted using a nationally representative sample and sample weights to mimic the demographic distribution of youth in the US. Second, we utilized both text and images in our aided ad recall measure, improving on prior studies that only assessed exposure to “*The Real Cost*” in telephone surveys. The use of a collage of images to aid participants in recall is a novel method comparable to other recent assessments of aided recall of a national e-cigarette prevention campaign (Hair et al., 2021). Furthermore, in addition to assessing recall of *The Real Cost* ads, we measured recall of a decoy ad. About 19% of participants recalled the decoy ad in our study, which is within the range of 7%-20% noted in other studies (Niederdeppe, 2014; Slater et al., 2011). We also accounted for potential recall bias of the *The Real Cost* ads by controlling for recall of the decoy ad in multivariable analyses ²¹.

4. Conclusion

This study assessed the aided recall of *The Real Cost* e-cigarette prevention ads. We identified relatively high and consistent recall across demographic subgroups among a nationally representative sample of adolescents. Findings support ongoing efforts by the FDA to reach youth with e-cigarette prevention messages using digital media. Ongoing research is needed to determine the influence of exposure to these ads on intermediate outcomes, such as attitudes and beliefs, and the impact of this campaign on vaping behaviors. It should also be noted that *The Real Cost* is one of many youth tobacco use prevention strategies. This campaign – in combination with other policy solutions (e.g., clean indoor air policies, flavor restrictions, limiting access) – may contribute to reductions in youth vaping.

5. Disclosures

SMN has served as a paid expert witness in government litigation against tobacco and e-cigarette companies.

CRediT authorship contribution statement

Rhyan N. Vereen: Conceptualization, Methodology, Writing – original draft. **Taylor J. Krajewski:** Methodology, Writing – original draft. **Euphy Y. Wu:** Methodology, Writing – original draft. **Jonathan H. Zhang:** Methodology, Writing – original draft. **Nora Sanzo:** Writing – original draft, Visualization. **Seth M. Noar:** Conceptualization, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: SMN has served as a paid expert witnesses in government litigation against tobacco and e-cigarette companies.

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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.2022.101864>.

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