

Original investigation

# Impact of Exposure to Electronic Cigarette Advertising on Susceptibility and Trial of Electronic Cigarettes and Cigarettes in US Young Adults: A Randomized Controlled Trial

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## Abstract

**Introduction:** This study assessed the impact of brief exposure to four electronic cigarette (e-cigarette) print advertisements (ads) on perceptions, intention, and subsequent use of e-cigarettes and cigarettes in US young adults.

**Methods:** A randomized controlled trial was conducted in a national sample of young adults from an online panel survey in 2013. Participants were randomized to ad exposure or control. Curiosity, intentions, and perceptions regarding e-cigarettes were assessed post-exposure and e-cigarette and cigarette use at 6-month follow-up. Analyses were conducted in 2014.

**Results:** Approximately 6% of young adults who had never used an e-cigarette at baseline tried an e-cigarette at 6-month follow-up, half of whom were current cigarette smokers at baseline. Compared to the control group, ad exposure was associated with greater curiosity to try an e-cigarette (18.3% exposed vs. 11.3% unexposed,  $AOR = 1.63$ , 95% CI = 1.18, 2.26) among never e-cigarette users and greater likelihood of e-cigarette trial at follow-up (3.6% exposed vs. 1.2% unexposed,  $AOR = 2.85$ ; 95% CI = 1.07, 7.61) among never users of cigarettes and e-cigarettes. Exploratory analyses did not find an association between ad exposure and cigarette trial or past 30-day use among never users, nor cigarette use among smokers over time. Curiosity mediated the relationship between ad exposure and e-cigarette trial among e-cigarette never users.

**Conclusions:** Exposure to e-cigarette ads may enhance curiosity and limited trial of e-cigarettes in never users. Future studies are needed to examine the net effect of curiosity and trial of e-cigarettes on longer-term patterns of tobacco use.

**Implications:** This randomized trial provides the first evidence of the effect of e-cigarette advertising on a behavioral outcome in young adults. Compared to the control group, ad exposure was

associated with greater curiosity to try an e-cigarette among never e-cigarette users and greater likelihood of e-cigarette trial at follow-up in a small number of never e-cigarette users and greater likelihood of e-cigarette trial at follow-up among never users of cigarettes and e-cigarettes.

## Introduction

Since their introduction to the US market in 2006,<sup>1</sup> awareness, interest, and use of electronic cigarettes (e-cigarettes) has increased<sup>2–6</sup> and in 2012–2013, 8.3% of young adults reported current e-cigarette use compared to 4.2% of adults overall.<sup>7</sup> In 2014, 17% of 12th grade students in the United States reported past 30-day e-cigarette use although 75% also reported lifetime combustible cigarette use.<sup>8</sup> Over the same time period that e-cigarette use has increased, the use of cigarettes has declined, with a record low prevalence of cigarette use in adolescents and adults in 2014.<sup>8,9</sup> Factors that drive e-cigarette use and influence patterns of other tobacco product use have been identified as a key research need.<sup>10</sup> One such factor is advertising, which has been demonstrated to promote the initiation and continued use of cigarettes.<sup>11–16</sup> Advertising is critical for raising awareness about newly introduced products,<sup>17</sup> and has been shown to influence initiation,<sup>13</sup> experimentation, and progression to regular combustible cigarette smoking in youth.<sup>12</sup> Across longitudinal studies, there is variation in strength of association between exposure to tobacco advertising and smoking behaviors in young people.<sup>12,18</sup> Experimental studies are needed to help estimate the causal effect of the influence of tobacco advertising on tobacco use in young people.

The three big US tobacco companies, Lorillard,<sup>19–21</sup> Reynolds American,<sup>22</sup> and Philip Morris,<sup>23</sup> as well as many independent e-cigarette companies, have invested significant resources in the e-cigarette sector. Promotional expenditures for e-cigarettes across all media channels have rapidly increased since 2010.<sup>24,25</sup> In 2013, over 60% of expenditures were for blu e-cigarettes (more than \$14 million), owned at that time by the Lorillard Tobacco Company, with the next greatest expenditure for NJOY, an independent e-cigarette company, at less than \$6 million.<sup>25</sup> Increased advertising has occurred concurrently with increased availability of e-cigarettes in tobacco shops, convenience stores, vapor shops, and pharmacies in recent years.<sup>26–28</sup> In an effort to curb the influence of advertising and reduce tobacco use, cigarette and smokeless manufacturers are prohibited from advertising on television or radio and from sponsoring sporting or entertainment events. E-cigarette manufacturers, however, are currently not subject to these regulations and some have advertised their products through all of these channels.<sup>29–33</sup>

The existence and aggressive marketing of e-cigarettes, although broadly accepted as much less harmful to individual users than combustible cigarettes,<sup>34</sup> may facilitate greater e-cigarette use among young people who otherwise would not have used any tobacco products. A hypothetical concern is, therefore, that increased curiosity and e-cigarette trial use could result in progression to lifelong combustible tobacco use in a sufficiently large number of young nonusers who otherwise would not have used tobacco, ultimately resulting in greater population harms than benefits. This concern is not borne out in existing data<sup>35,36</sup> which show consistent declines in cigarette use from 2010 to 2014,<sup>8</sup> but continued studies are needed to discern the net impact of e-cigarettes and e-cigarette advertising on tobacco use patterns among young people over time.<sup>37</sup>

Young adulthood is a critical developmental period that often coincides with the establishment of tobacco use.<sup>38</sup> Given

that young adults are also a target audience of the tobacco industry,<sup>39,40</sup> which is increasingly investing in and promoting e-cigarettes and also benefits financially from progression to combustible cigarettes,<sup>35</sup> it is important to examine how young adults perceive and are affected by e-cigarette advertising and how this influences their use of combustible cigarettes or other tobacco products. The purpose of this randomized study was to assess the impact of a brief exposure to e-cigarette ads on perceptions, intentions, and subsequent use of e-cigarettes and cigarettes in a national, longitudinal sample of young adults.

## Methods

The Truth Initiative Young Adult Cohort Study was designed to understand the trajectories of tobacco use in a young adult population using a longitudinal cohort sample. Details of the cohort have been described elsewhere.<sup>41</sup> Briefly, the cohort is comprised of a nationally representative sample of young adults ages 18–34 drawn from GfK's KnowledgePanel. KnowledgePanel is an online panel of adults ages 18 and older that covers both the online and offline populations in the United States ([www.knowledgenetworks.com/knpanel/index.html](http://www.knowledgenetworks.com/knpanel/index.html)). The panel was recruited via address-based sampling, a probability-based random sampling method that provides statistically valid representation of the US population, including cell phone-only households. African American and Hispanic young adults were oversampled to ensure sufficient sample sizes for subgroup analyses. The validity of this methodology has been reported previously,<sup>42,43</sup> and it has been used broadly in the peer-reviewed medical literature.<sup>44–47</sup> The baseline survey (Wave 1;  $n = 4201$ ) was conducted in July 2011, with subsequent assessments occurring approximately every 6 months; the study is ongoing (Wave 8, July 2015). The cohort is refreshed at each wave to retain the initial sample size.

The current study uses data from the Wave 4 survey, which were collected in January 2013 ( $N = 4288$ ) and Wave 5 follow-up data collected in July 2013 ( $N = 3196$ ; 74.5% of original sample). The panel recruitment rate (RECR)<sup>48</sup> for Wave 4 was 14.7%. In 65.5% of the identified households, one member completed a core profile survey in which the key demographic information was collected (profile rate—PROR). For this particular study, only one panel member per household was randomly selected to be part of the study sample and no members outside the panel were recruited. The completion rate (COMR) was 65.7%. Thus, the product of these three rates, the cumulative response rate (CUMRR1), was 6.3%. This study was approved by the Chesapeake Institutional Review Board, Inc, and online consent was collected from participants before survey self-administration.

## Intervention

All participants responding to the Wave 4 survey were included in a randomized controlled trial on e-cigarette advertising and were randomized in a 1:1 ratio to one of two conditions using a computer-generated sequence within the survey software, thus concealing the allocation sequence from investigators and participants. Given the lack of preliminary data on this topic, an effect size for power

calculations was not estimated prior to the start of the experiment, though post hoc power analyses indicated adequate power to detect the effect of ad exposure on e-cigarette perceptions, curiosity to try an e-cigarette, and would try an e-cigarette if offered by a friend in the full sample and e-cigarette trial at follow-up among e-cigarette never users and never users of both cigarettes and e-cigarettes. Half ( $n = 2110$ ) were exposed to four different e-cigarette ads (blu, Fin, NJOY, White Cloud), and those remaining ( $n = 2178$ ) were designated as the control group and were not exposed to any ads. Ad order was not randomized or counterbalanced within the exposed group. These ads were chosen from a comprehensive advertising surveillance system (Competitrack; [www.competitrack.com](http://www.competitrack.com)); three of the ads were presented in print media (blu, Fin, NJOY), with the fourth presented in an online display (White Cloud). In 2012, the blu ad had the largest reach with 18 insertions and an estimated total spend of \$1 730 800, followed by the NJOY ad (estimated \$327 700 spend for three insertions), the Fin ad (estimated \$124 700 spend for one insertion), and White Cloud (estimated \$392 spend for 11 days on a website).

## Measures

### Outcomes

Outcomes of interest related to curiosity about e-cigarettes, likelihood of e-cigarette use, consumer perceptions of e-cigarettes (all three questions asked of all participants at Wave 4 at the same point in the survey, which followed ad exposure in the exposed group), and e-cigarette and cigarette trial among e-cigarette never users at 6-month follow-up (Wave 5). The first item was "Have you ever been curious about smoking e-cigarettes?" The next two items were based on measures of susceptibility to cigarette smoking among adolescents<sup>13,49</sup>: "Do you think that you will try an e-cigarette soon?" and "If one of your best friends were to offer you an e-cigarette, would you try it?" These three items had the following response choices: "Definitely yes," "Probably yes," "Probably not," and "Definitely not." In exploratory analyses, there were few differences between probably and definitely responses, so each item was analyzed as a dichotomous variable: probably/definitely not or definitely/probably yes. Analyses for these three items focused on the subgroup of participants in both study conditions who had never used an e-cigarette. The final items evaluated consumer perceptions of e-cigarettes. All participants were asked whether the following statements were true or false: (1) "People can smoke e-cigarettes in places where smoking regular cigarettes isn't allowed"; (2) "Using e-cigarettes can help people quit smoking regular cigarettes"; (3) "E-cigarettes come in appealing flavors"; (4) "E-cigarettes don't produce second-hand smoke"; and (5) "E-cigarette smoking is cheaper than smoking regular cigarettes." E-cigarette trial at 6-month follow-up was estimated as ever use of e-cigarettes at Wave 5 among participants who reported never use of e-cigarettes at Wave 4. Cigarette trial was estimated as ever use of cigarettes at Wave 5 among participants who reported never use at Wave 4. Among cigarette users at Wave 4, mean smoking frequency and intensity in the past 30 days were assessed at Wave 5. Past 30-day e-cigarette and cigarette use at Wave 5 was also assessed among never users at Wave 4.

### Covariates

#### Smoking Status

Given young adults' variability in cigarette smoking behaviors and identification, smoking status was assessed by reports of smoking behavior and self-identified smoking status. Unlike many adult surveys of tobacco use, participants did not have to meet a 100-unit

threshold to be considered a current user. At Wave 4, ever use of cigarettes or e-cigarettes was defined as any prior use, even a puff. Current use of each product was asked only of ever users and was defined as any use in the past 30 days; to maintain the full denominator, those who used on zero days, had never used the product, or refused to answer these questions were defined as noncurrent users.

Participants were also asked to report their self-identified cigarette smoking status using the following item: "Which of the following best describes how you think of yourself?" with response choices of "Smoker," "Social smoker," "Occasional smoker," "Ex-smoker," "Someone who tried smoking" and "Non-smoker." "Social" and "Occasional" smokers were collapsed into a single category for these analyses.

#### Other Influences on Smoking

Peer smoking and exposure to other tobacco advertising in the past 6 months were examined at Wave 4 as other possible influences on e-cigarette use. Peer smoking was evaluated using the following item: "How many of your 4 closest friends smoke cigarettes?" with respondents entering a number between 0 and 4. The responses were dichotomized as "0" and "1 or more." Exposure to tobacco advertising was assessed by asking, "In the past 6 months, have you done any of the following? Select all that apply" with the following response choices: (1) "Visited and/or registered on a tobacco company or product website," (2) "Visited, friended or otherwise engaged with a Facebook or other social media page dedicated to a tobacco product," (3) "Been exposed to and/or participated in a tobacco product event at a festival, concert, bar or clubs," and (4) "Received direct mail or email advertising tobacco products." Susceptibility to smoking cigarettes among noncurrent smokers was assessed using measures validated in adolescents<sup>13,49</sup>: "Will you try a cigarette anytime in the next year?" and "If one of your best friends were to offer you an e-cigarette, would you try it?" These two items had the following response choices: "Definitely yes," "Probably yes," "Probably not," and "Definitely not." Never cigarette smokers who responded "definitely not" to both items were classified as "closed to smoking" and all others were classified as "susceptible to smoking cigarettes."

#### Other Control Variables

Sociodemographic items assessed included age at study entry (grouped as 18–24 and 25–34), gender, race/ethnicity (white, non-Hispanic; black, non-Hispanic; Other, non-Hispanic; and Hispanic), educational attainment (less than high school, high school, and some college or greater) and ratio of household income to 2012 poverty threshold (less than 1, greater than 1).

### Data Analysis

All analyses were performed in 2014 using SVY procedures in Stata IC 13.1 (StataCorp, 2014) and two sets of post-stratification weights were used to offset any nonresponse or noncoverage bias and produce nationally representative estimates. Analyses using baseline data only used Wave 4 weights and analyses of outcomes at follow-up used weights that accounted for attrition between Waves 4 and 5. Since the proportion of missing data was minimal, missing data were handled with listwise deletion per Stata's survey procedures. All analyses were conducted by original assigned groups and analysts were not blinded to study condition when running outcome analyses. Bivariate analyses were conducted to provide descriptive characteristics of the sample by study group and assess the associations

between study group and the outcome variables. Odds ratios were adjusted for variables where there was potential imbalance between study groups at the  $P < .2$  level. Post hoc analyses using the *medeff* command in Stata assessed the extent to which curiosity to try e-cigarettes mediates the association between study group and e-cigarette trial.<sup>50,51</sup> This command incorporates robust standard errors adjusting for sampling weights and provides the proportion of total effect mediated and the corresponding 95% confidence interval.

## Results

### Participant Characteristics

Figure 1 depicts the flow of participants from enrollment through follow-up. The present study sample was comprised of 4288 young adults aged 18–34 years at cohort entry with 41.7% aged 18–24 years (Table 1). The exposed and unexposed study groups were equivalent on sociodemographic characteristics. Nearly 58% of the sample was non-Hispanic white, with 12.7% non-Hispanic black, 20.7% Hispanic, and 8.9% non-Hispanic “Other” race. The majority (60.3%) of participants had at least some college education, and 74.5% of participants lived above the federal poverty line. Among young adults in the sample, 70% had heard of e-cigarettes, 8% had ever used an e-cigarette, and 2% had used an e-cigarette in the past 30 days. A significantly higher proportion of the unexposed group had ever used e-cigarettes relative to the exposed group (9.2% vs. 6.8%, respectively;  $P = .032$ ). Though 18.8% of participants reported smoking cigarettes in the past 30 days and 43.8% reported ever use of cigarettes, only 10.4% described themselves as smokers, with an additional 10.6% describing themselves as social or occasional smokers,

7.4% as ex-smokers, 9.0% as someone who had tried smoking, and 62.7% as nonsmokers. The prevalence of engagement with tobacco marketing ranged from 4.2% ever visiting a tobacco company website, to 16.5% receiving tobacco product direct mail or email advertisements. A difference by study group was observed for being exposed to a tobacco product event and receiving direct mail/email tobacco product ads, with a significantly higher proportion of the exposed group endorsing these items compared to the unexposed group. There were no differences in the proportions reporting peer cigarette smoking or susceptibility to smoke cigarettes across the study groups.

Seventy-five percent of the Wave 4 participants ( $n = 3196$ ) were retained in the study sample at 6-month follow-up (Wave 5). There were no significant differences on age or gender among those retained versus those lost to follow-up. However, significantly more participants who were white ( $P = .001$ ) or who had completed at least some college ( $P = .001$ ) were retained, while significantly more participants who were Hispanic ( $P < .002$ ) or had not completed high school were lost ( $P = .004$ ) at the 6-month follow up. Additionally, participants lost to follow-up had lower income relative to those retained ( $P < .001$ ) and reported having “visited, friended or otherwise engaged with a Facebook or other social media page dedicated to a tobacco product” at a higher level than those retained ( $P = .004$ ). This pattern held when looking only at e-cigarette never users at Wave 4. There were no significant differences in e-cigarette awareness, e-cigarette ever use or cigarette ever use among those lost to follow-up versus those retained; however, a greater proportion of individuals who identified as nonsmokers were retained ( $P = .006$ ) and those retained were less likely to report peer smoking than those lost to follow-up ( $P < .001$ ).

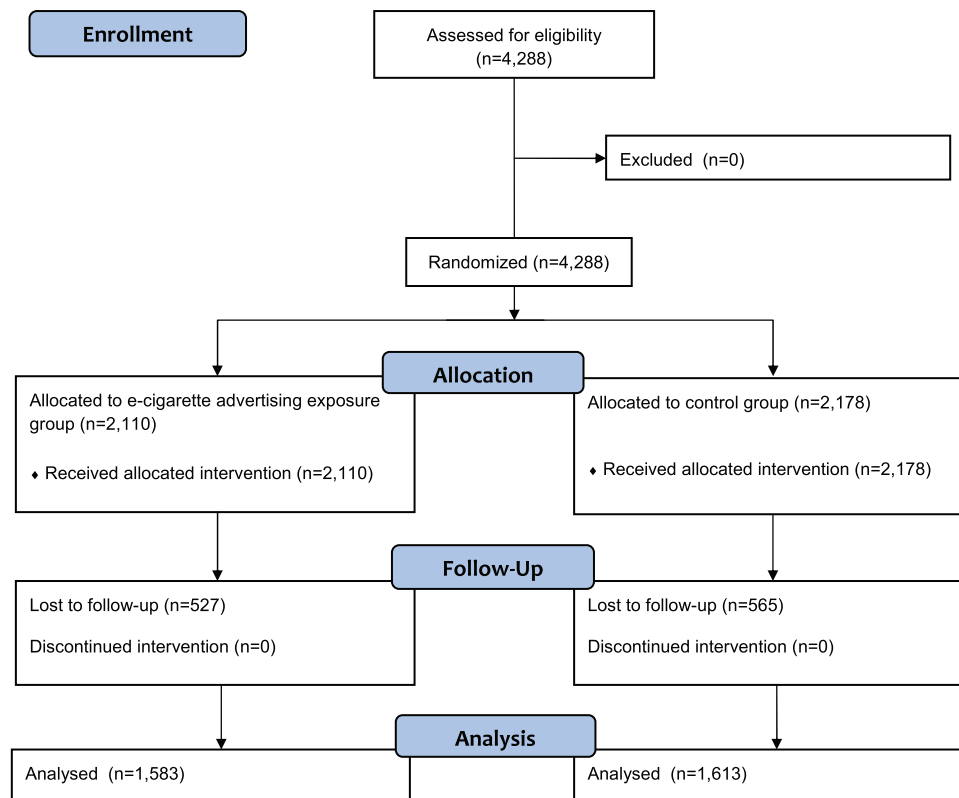


Figure 1. Electronic cigarette advertising experiment CONSORT diagram (unweighted).

**Table 1.** Participant Characteristics by Study Group (Weighted  $n = 4288$ )

Participant characteristics	Study group		Total ( $n = 4288$ )	<i>P</i>
	Exposed ( $n = 2093$ )	Unexposed ( $n = 2195$ )		
Gender (%)				
Male	49.1	50.0	49.6	.701
Female	50.9	50.0	50.4	
Age at study entry				
18–24	42.4	41.0	41.7	.543
25–34	57.6	59.0	58.3	
Continuous (mean, <i>SD</i> )	25.90, 5.07	26.03, 4.97	25.97, 5.02	.577
Race/ethnicity (%)				
White, non-Hispanic	58.6	56.9	57.7	.393
Black, non-Hispanic	12.6	12.8	12.7	
Other, non-Hispanic	9.6	8.2	8.9	
Hispanic	19.2	22.2	20.7	
Education (%)				
Less than high school	11.3	12.8	12.1	.393
High school	27.5	27.7	27.6	
Some college or more	61.2	59.6	60.3	
Income to poverty <sup>a</sup> ratio 1+ (%)	75.1	74.0	74.5	.613
Exposure to other tobacco advertising (%)				
Visited/registered on tobacco company website	4.1	4.3	4.2	.839
Engaged with a tobacco social media page	5.2	5.2	5.2	.946
Exposed to/participated in tobacco product event	10.2	7.5	8.8	<b>.041</b>
Received direct mail/email tobacco product ads	18.4	14.6	16.5	<b>.030</b>
Tobacco-use related items				
E-cigarette awareness and use				
Ever heard of e-cigarettes (%)	69.8	70.2	70.0	.709
Ever e-cigarette user (%)	6.8	9.2	8.0	<b>.032</b>
Current e-cigarette use <sup>b</sup> (%)	2.0	2.0	2.0	.882
Cigarette use				
Ever cigarette user (%)	42.6	44.9	43.8	.321
Current cigarette use <sup>b</sup> (%)	20.4	17.2	18.8	.071
Self-identified smoking status (%)				
Smoker	10.9	9.9	10.4	.257
Social/occasional smoker	11.3	9.9	10.6	
Ex-smoker	8.3	6.5	7.4	
Tried smoking	8.1	9.7	9.0	
Nonsmoker	61.4	64.0	62.7	
Peer smoking—none vs. $\geq 1$ of closest friends smoke cigarettes (%)	51.1	54.3	52.7	.158
Susceptible to smoking cigarettes <sup>c</sup>	19.8	18.4	19.1	.503

E-cigarette = electronic cigarette.  $P < .05$  noted in bold text.

<sup>a</sup>Using 2012 poverty guidelines.

<sup>b</sup>Current user defined as used product one or more days in past 30 days.

<sup>c</sup>Among noncurrent cigarette users (weighted  $n = 3429$ ).

### E-Cigarette Perceptions, Overall and by Study Group

Overall, the most common perception concerning e-cigarettes was that they do not produce secondhand smoke (73.9%), followed by the perception that e-cigarettes can help smokers quit (66.9%), come in appealing flavors (66.3%), can be used where cigarette smoking is not allowed (65.4%), and are cheaper than regular cigarettes (45.8%; [Table 2](#)). Endorsement of each of these perceptions was significantly higher in the exposed group compared to the unexposed group (all  $P < .05$ ).

### Curiosity About and Intention to Try E-Cigarettes Among E-Cigarette Never Users

Among young adults who had never used an e-cigarette (weighted  $n = 3944$ ), 14.8% reported that they were curious to try an e-cigarette,

with a greater percentage of the exposed (18.3%) versus unexposed group (11.3%) reporting curiosity. Controlling for exposure to a tobacco product event, receipt of direct mail/e-mail tobacco product ads, self-identified smoking status, and peer smoking, e-cigarette never users in the exposed group remained significantly more likely to report curiosity to try an e-cigarette compared to those in the unexposed group (adjusted odds ratio [AOR] = 1.63, 95% confidence interval [CI] = 1.18, 2.26; [Table 3](#)). Overall, 17.7% of the sample who had never used e-cigarettes at baseline reported that they would try an e-cigarette if offered by a friend. This differed by study group (20.2% exposed vs. 15.3% unexposed;  $P = .010$ ). The percentage of young adults who had never used an e-cigarette, but reported that they would try an e-cigarette soon (7.5%) did not vary by study group (8.1% exposed vs. 6.8% unexposed).

**Table 2.** Outcomes by Study Group (Full Sample Weighted  $n = 4288$ )

	Study group		Total ( $n = 4288$ )	P
	Exposed ( $n = 2093$ )	Unexposed ( $n = 2195$ )		
E-cigarette perceptions (% true)				
Can smoke e-cigarettes where smoking regular cigarettes are not allowed	67.9	63.0	65.4	.029
Using e-cigarettes can help people quit smoking regular cigarettes	69.9	64.1	66.9	.007
E-cigarettes come in appealing flavors	68.6	64.0	66.3	.033
E-cigarettes don't produce secondhand smoke	76.3	71.7	73.9	.025
E-cigarette smoking is cheaper than smoking regular cigarettes	48.6	43.0	45.8	.014
	( $n = 1952$ )	( $n = 1993$ )	( $n = 3944$ )	
E-cigarette intentions among e-cigarette never users (%)				
Ever curious about smoking e-cigarettes	18.3	11.3	14.8	.001
Will try an e-cigarette soon <sup>b</sup>	8.1	6.8	7.5	.365
Would try e-cigarette if offered by a friend	20.2	15.3	17.7	.010
	( $n = 1493$ )	( $n = 1470$ )	( $n = 2964$ )	
E-cigarette trial at 6-month follow-up (%)				
Among all e-cigarette never users at baseline	7.9	4.7	6.3	.010
Among never users of both cigarettes and e-cigarettes at baseline	3.6	1.2	2.4	.020
Past 30-day e-cigarette use at 6-month follow-up (%)				
Among all e-cigarette never users at baseline <sup>b</sup>	2.7	2.1	2.4	.442
Among never users of both cigarettes and e-cigarettes at baseline <sup>b</sup>	1.4	0.6	1.0	.175
	( $n = 934$ )	( $n = 921$ )	( $n = 1855$ )	
Cigarette trial at 6-month follow-up (%)				
Among all cigarette never users at baseline <sup>b</sup>	11.7	8.2	10.0	.096
Among never users of both cigarettes and e-cigarettes at baseline <sup>b</sup>	11.5	8.1	9.8	.109
Past 30-day cigarette use at 6-month follow-up (%)				
Among all cigarette never users at baseline <sup>b</sup>	4.5	2.5	3.5	.157
Among never users of both cigarettes and e-cigarettes at baseline <sup>b</sup>	4.5	2.4	3.5	.140
	( $n = 220$ )	( $n = 240$ )	( $n = 460$ )	
Cigarette use at 6-month follow-up among cigarette users at baseline (mean)				
Change in number of days used cigarettes in past month <sup>b</sup>	0.92	-0.13	0.42	.410
Change in number of cigarettes used on days smoked <sup>a,b</sup>	-0.07	0.46	-0.09	.414

E-cigarette = electronic cigarette.  $P < .05$  noted in bold text.

<sup>a</sup>For this measure, weighted sample size is  $n = 374$  ( $n = 197$  exposed;  $n = 177$  unexposed).

<sup>b</sup>The study was underpowered to detect differences in the impact of ad exposure on these outcomes.

### Trial of E-Cigarettes at 6 Months Among E-Cigarettes Never Users

At follow-up, 6.3% of the e-cigarette never users at baseline (weighted  $n = 2964$ ) reported trying e-cigarettes, with approximately half (3.2%) of triers reporting current cigarette smoking at baseline. E-cigarette never users exposed to e-cigarette ads were more likely to have tried an e-cigarette than those unexposed (7.9% vs. 4.7%), though this was marginally significant in the multivariable analysis (AOR = 1.53; 95% CI = 0.98, 2.39; Table 3). When these results were examined by cigarette smoking status, there were no differences in e-cigarette trial by study group among ever smokers or current smokers at baseline, but ad exposure was significantly associated with e-cigarette trial among never users of both e-cigarettes and cigarettes at baseline (3.6% vs. 1.2%; AOR = 2.85; 95% CI = 1.07, 7.61; Table 3).

### Secondary Outcomes

The effect of ad exposure on secondary outcomes were explored, but the study was underpowered to detect study group differences in past 30-day e-cigarette or cigarette use, cigarette trial, or changes in cigarette use. As such, no changes were detected between study groups for these outcomes. Results are presented in Table 2 to provide starting estimates for adequately powering future studies.

### Curiosity as a Mediator of E-Cigarette Trial

In exploratory mediation analyses, ad exposure was independently associated with curiosity to try an e-cigarette (odds ratio [OR] = 1.80;  $P = .001$ ) and e-cigarette trial at 6-month follow-up (OR = 1.71;  $P = .015$ ) among e-cigarette never users. Curiosity was measured at Wave 4 for both groups, and was assessed directly after viewing the e-cigarette ads among the exposed group. Curiosity was

**Table 3.** Crude and Adjusted Odds Ratios (AOR) for Effect of E-Cigarette (Electronic Cigarette) Advertising Exposure on E-Cigarette and Cigarette Use Outcomes

	<i>n</i> <sup>a</sup>	Crude OR	95% CI	<i>n</i> <sup>a</sup>	AOR	95% CI
Intention-related outcomes among e-cigarette never users <sup>b</sup>						
Ever curious about smoking e-cigarettes	3905	1.75	1.32–2.32	3843	1.63 <sup>c</sup>	1.18–2.26
Would try e-cigarette if offered by a friend	3880	1.40	1.08–1.80	3829	1.17 <sup>c</sup>	0.85–1.62
E-cigarette trial at 6-month follow-up <sup>d</sup>						
Among all e-cigarette never users at baseline	2964	1.74	1.13–2.68	2899	1.53 <sup>c</sup>	0.98–2.39
Among never users of both cigarettes and e-cigarettes at baseline	1842	3.15	1.14–8.72	1786	2.85 <sup>c</sup>	1.07–7.61

CI = confidence interval. *P* < .05 noted in bold text.

<sup>a</sup>Weighted *n*.

<sup>b</sup>Survey weights for full sample at Wave 4.

<sup>c</sup>Odds ratio adjusted for four potential confounders at *P* < .2 in bivariate analysis (exposed to/participated in tobacco product event, received direct/e-mail tobacco product ads, self-identified smoking status, peer smoking).

<sup>d</sup>Survey weights for participants completing both Waves 4 and 5.

<sup>e</sup>Odds ratio adjusted for four potential confounders at *P* < .2 in bivariate analysis (education, exposed to/participated in tobacco product event, received direct/e-mail tobacco product ads, peer smoking).

also an independent predictor of e-cigarette trial (*OR* = 7.34; *P* < .001) among e-cigarette never users. When curiosity was added to the overall model, study group was no longer a significant predictor of e-cigarette trial while curiosity remained highly significant (*OR* = 7.01, *P* < .001). Results of the more formal test of the mediation effect indicate that curiosity mediated 40% (95% CI = 20.3–55.9) of the total effect of study group on e-cigarette trial at Wave 5. These findings support curiosity to try an e-cigarette as a partial mediator of the relationship between study group and e-cigarette trial.

## Discussion

This randomized trial indicates that a brief exposure to e-cigarette advertising significantly increased curiosity to try an e-cigarette and willingness to try an e-cigarette if offered by a friend in the 92% of our national sample of US young adults who had never used an e-cigarette at baseline. Ad exposure also increased the likelihood of e-cigarette trial in respondents who had never used an e-cigarette at baseline (92%) and in the 56% of respondents who had never used a cigarette or an e-cigarette at baseline. Exploratory analyses indicated that exposure to e-cigarette ads did not significantly increase trial of combustible cigarettes in the 10% of young adults who reported trying cigarettes for the first time between Waves 4 and 5 (assessed in 43% of the initial sample), though this may be due to low power or to the fact that young adults have had a greater opportunity to try cigarettes in their lifetime compared to the relatively recent availability of e-cigarettes. In exploratory analyses, curiosity was a significant predictor of e-cigarette trial at 6-month follow-up among e-cigarette never users. Previous prospective studies in young people have shown that curiosity is directly associated with smoking initiation in adolescents, independent of susceptibility, or likelihood, of smoking.<sup>52</sup> Our study supports and extends these findings to suggest that curiosity is a mediator of the relationship between advertising exposure and subsequent trial of e-cigarettes in young adults. A recent study in adolescents<sup>53</sup> showed that a brief advertising exposure affected intention to use e-cigarettes; our study was underpowered to assess this outcome in e-cigarette never user young adults. Our findings showed, however, that ad exposure was associated with positive perceptions about e-cigarettes in the full sample, including that e-cigarettes can help people quit smoking. Consumer

perceptions related to cessation have also been shown to be directly associated with future e-cigarette use in young adults.<sup>54</sup> In our study, exposure to the e-cigarette ads did not alter cigarette smoking frequency or intensity among young adult smokers over a 6-month period.

This study uses an existing online panel to recruit a large, nationally representative cohort of young adults, a group typically identified as hard-to-reach. The study sample's completion rate (65.7%) and cumulative response rate (6.3%) are similar to that of other health studies that have relied on KnowledgePanel.<sup>45,55,56</sup> The internal validity of our findings is not compromised by the panel's cumulative response rate and other work suggests that surveys with a low response rate can still be representative of the sample population, even though the risk of nonresponse bias is higher.<sup>57,58</sup> Studies assessing nonresponse to panel recruitment in KnowledgePanel have found little indication of nonresponse bias on core demographic and socioeconomic variables<sup>59,60</sup> and previous estimates from this cohort for key outcomes of interest, such as ever and current cigarette use, are consistent with national survey data.<sup>41</sup>

Our analyses in this article focus on two waves of survey data in which participants were randomly assigned to exposure to four e-cigarette ads or no exposure and followed for 6 months. Findings relating ad exposure to curiosity, likelihood of e-cigarette use, and consumer perceptions are correlational, though items were ordered within the survey to provide the best estimate of the impact of these outcomes. Two main strengths of this study are (1) its longitudinal design, which allows for the investigation of a temporal relationship between ad exposure, increased curiosity to try e-cigarettes and subsequent trial of cigarettes and e-cigarettes among never users, and (2) its randomized design.

There are several limitations in this study. First, the magnitude of the effect of brief exposure to e-cigarette advertising on our outcomes may be due to the small sample of ads chosen, the order in which they were presented or the particular ads chosen. Choosing a different number of ads, a series of ads produced by the same company, ads with different thematic or stylistic content, or randomizing the order of the ads may have resulted in a different effect. Additionally, the unexposed group was likely to have been exposed to e-cigarette ads given a recent study showing that 75.4% of US adults were aware of e-cigarettes with nearly 50% having heard of e-cigarettes on television.<sup>5</sup> Since prior exposure to e-cigarette ads were not captured

among the unexposed young adults in our study, there may, in fact, be a greater impact of e-cigarette ads on perceptions and intention to use e-cigarettes. Second, the brief exposure to static ads presented in this study is likely weak compared to the exposure encountered by young adults in the real world. While the exposed and unexposed groups reported similar levels of awareness of e-cigarettes at Waves 4 and 5, we cannot determine the degree to which they were exposed to e-cigarette advertising between waves, nor whether the exposed group became more aware of e-cigarette advertising as a result of the experiment, magnifying the impact of the initial exposure on subsequent e-cigarette trial. Third, participants in the control arm were not exposed to any ad, nor was the order of the ads randomly presented to those in the exposed group. The results of the study, therefore, may be more related to ad exposure in general or ad order. Fourth, the chosen ads are unlikely to represent the full range of e-cigarette marketing done by a particular company, which may include television, radio, internet, print, and point-of-sale advertisements. Finally, this study cannot tease apart the potentially variable effects of different themes of e-cigarette messaging on e-cigarette curiosity, trial and use.

The current study highlights the potential impact of e-cigarette advertisements to enhance curiosity and trial of e-cigarette use among young adults. Study findings on the relationship of ad exposure and trial among never users of both cigarettes and e-cigarettes echo concerns regarding the consequences to young people of unrestricted marketing of e-cigarettes.<sup>33</sup> This study was not powered to determine whether e-cigarette advertising is a catalyst for regular use of e-cigarettes or cigarettes among never users, which is currently of public health concern. Future studies are needed to examine the implications for public health of advertising messages and trial use of e-cigarettes in terms of whether e-cigarette use decreases, increases, or has no population level impact on patterns of combustible tobacco use, particularly among youth and young adults.<sup>35,61,62</sup>

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## Declaration of Interests

None declared.

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