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The Effect of Potential Electronic Nicotine Delivery System Regulations on Nicotine Product Selection

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Abstract

Aims—To estimate the effect of potential regulations of electronic nicotine delivery systems (ENDS) among adult smokers, including increasing taxes, reducing flavour availability, and adding warning labels communicating various levels of risk.

Design—We performed a discrete choice experiment (DCE) among a national sample of 1,200 adult smokers. We examined heterogeneity in policy responses by age, cigarette quitting interest, and current ENDS use. Our experiment overlapped January, 2015 by design, providing exogenous variation in cigarette quitting interest from New Year resolutions.

Setting—KnowledgePanel, an online panel of recruited respondents.

Participants—1,200 adult smokers from the United States.

Measurements—Hypothetical purchase choice of cigarettes, nicotine replacement therapy, and a disposable ENDS.

Findings—Increasing ENDS prices from \$3 to \$6 was associated with a 13.6 percentage point reduction in ENDS selection ($p < 0.001$). Restricting flavour availability in ENDS to tobacco and menthol was associated with a 2.1 percentage point reduction in ENDS selection ($p < 0.001$). The proposed FDA warning label was associated with a 1.1 percentage point reduction in ENDS selection ($p < 0.05$), and the MarkTen warning label with a 5.1 percentage point reduction ($p < 0.001$). We estimated an ENDS price elasticity of -1.8 ($p < 0.001$) among adult smokers. Statistically significant interaction terms ($p < 0.001$) imply that price responsiveness was higher among adult smokers 18–24 years of age, smokers who have vaped over the last month, and smokers with above the median quitting interest. Young adult smokers were 3.7 percentage points more likely to choose ENDS when multiple flavours were available than older adults ($p < 0.001$).

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Conflict of interest:

The authors have no conflicts of interest to disclose.

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M Pesko and D Kenkel conceptualized the study. M Pesko and J Hughes drafted the article. H Wang led the data analysis. All authors contributed to data interpretation and critically revised the article.

Young adult smokers and those with above the median cigarette quitting interest were also more likely to reduce cigarette selection and increase ENDS selection in January, 2015 ($p<0.001$), potentially in response to New Year's resolutions to quit smoking.

Conclusions—Increased taxes, a proposed US Food and Drug Administration warning label for electronic nicotine delivery systems (ENDS) and a more severe warning label may discourage adult smokers from switching to ENDS. Reducing the availability of flavours may reduce ENDS use by young adult smokers.

Introduction

The emergence of electronic nicotine delivery systems (ENDS) is rapidly changing the tobacco marketplace. ENDS are vaping devices that deliver nicotine through an aerosol mist and range in disposability, customization, and price (1). Most adult users of ENDS also smoke conventional cigarettes and rates of attempting to quit smoking using ENDS products are high (2–5). While sales of e-cigarettes in the United States have increased from \$20 million in 2008 to \$1.5 billion in 2014 (6, 7), sales of cigarettes have gradually fallen by 29.6 percent from 2004 to 2014 (7).

ENDS may be a harm-reduction strategy for adult smokers (8). They have been associated with successful smoking reduction, sometimes with greater success than with nicotine replacement therapy (NRT) (5, 8–10). ENDS products are not harmless as they contain nicotine and low levels of carcinogens (11, 12) and have been associated with symptoms such as airway obstruction, increased diastolic blood pressure, increased heart rate, palpitation, cough, and throat irritation (13). However smokers switching to ENDS have reported fewer adverse health effects with ENDS use than cigarette use (14). Policies to encourage smokers who cannot or do not want to stop smoking to switch to ENDS have been proposed as a way to reduce smoking-related disease, death, and health inequalities (10).

There has been a worldwide effort to regulate ENDS. As of May 2015, 71 countries regulate ENDS using national/federal legislation. 26 countries have instituted bans against all sales of ENDS, including Argentina, Brazil, Mexico, Greece, Turkey, Saudi Arabia, and Thailand. 16 countries have minimum legal purchase ages for ENDS, all with minimum ages of 18 years except South Korea (19 years) and Honduras (21 years). Two countries, South Korea and Togo, tax ENDS (15).

In this paper, we contribute evidence on key questions faced by policymakers considering regulating ENDS by examining purchasing decisions made by adult smokers in the United States. In the U.S., ENDS regulations have been slowly evolving. The Food and Drug Administration's Center for Tobacco Products (FDA-CTP) was vested with broad authorities under the 2009 Family Smoking Prevention and Tobacco Control Act (FSPTCA) to regulate tobacco products. The FDA only regulates ENDS marketed as therapeutic (16), but the FDA-CTP is considering a rule to assert its jurisdiction over ENDS and require that ENDS products carry a health warning (17).

Warning labels on conventional cigarettes have differing levels of deterrence based on the design and messages they incorporate (18, 19), thus the ultimate choice of labels selected by the FDA-CTP may influence demand for ENDS. Warning labels, in the form of a small text label, have been mandated for cigarette packages in the U.S. since 1984. Four rotating warning labels are currently used in cigarettes and are displayed in Figure 1A (20). The FDA-CTP's current proposed warning label for ENDS is in Figure 1B (17). Despite no legal requirement to display warning labels on their products, some ENDS manufacturers voluntarily do so. One ENDS manufacturer Nu Mark (an Altria Company) has included a more stringent warning label (21). Internationally, graphic designs and more prominent warning labels on cigarettes have been associated with increased impact (18, 22), but they are unlikely to be used for ENDS in the U.S. because they are not currently allowed for other tobacco products (23).

ENDS are currently available in multiple flavours including menthol, fruit, candy, dessert, alcohol, and a variety of novelty flavours (24, 25). In contrast, the 2009 FSPTCA prohibits flavours other than menthol in combustible cigarettes. The prohibition is seen as a way of discouraging smoking initiation and uptake, because younger people are known to prefer flavoured versus unflavoured nicotine products (10, 26). Though the FDA-CTP has regulatory authority to restrict the use of flavours in ENDS, no flavour regulation is currently proposed.

One regulation that the ENDS industry has largely avoided is taxes. Only South Korea and Togo currently tax ENDS on a national/federal level (15). In the U.S., whereas the weighted state cigarette excise tax was \$1.28 per pack and federal excise tax \$1.01 per pack in 2013 (27), as of September, 2015 only five states and the District of Columbia had enacted ENDS taxes and there is no federal excise tax (28). Potentially because of perceived harm reduction properties of ENDS, 12 proposed state tax increases have failed (29). While the consensus price elasticity estimate for cigarettes is approximately -0.4 , meaning that a 10% price increase results in a 4% decrease in cigarette purchases (30), current research indicates ENDS price responsiveness may be more elastic. One study found disposable ENDS and reusable ENDS price elasticities at approximately -1.2 and -1.9 respectively (31). Cigarettes have been found to be substitute goods for ENDS in one experimental study in adults (32), but another found no consistent relationship in market observation (31).

In order to identify the effects that warning labels, flavour regulations, and prices may have on the choice of nicotine-containing products, this study has aimed to simulate the choice of nicotine-containing products with a discrete choice experiment (DCE) design. In a DCE, respondents make hypothetical choices to purchase products and the product attributes are varied to identify consumer preferences over the attributes (33). By experimentally varying ENDS warning labels, flavours, and prices, in a series of choice experiments, we aim to determine preferences and relative importance placed on each of these factors. To analyze useful cigarette quitting interest variation occurring naturally during the year, we also compare choices before and after January, 2015. The beginning of the year is associated with a significant rise in quit attempts (attributed to New Year's resolutions) (34), and warning label responsiveness has been found to be stronger in those intending to quit (35). Identifying these preferences will help inform the international discussion of how to regulate

ENDS in a manner that neither encourages youths and other nonsmokers to start using nicotine products nor discourages current smokers from quitting.

Methods

Data

We performed a discrete choice experiment (DCE) among 1,200 adult smokers surveyed through KnowledgePanel (36). The DCE was completed between December, 2014 and January, 2015. The goal of our DCE is to study how adult smokers are influenced to purchase ENDS based on costs, warning labels, and flavours. We received IRB approval from Cornell University and the University of Illinois at Chicago to perform this study.

KnowledgePanel recruits individuals for the panel using address-based sampling. This recruitment includes individuals using only cell phones and individuals without computer/internet (which KnowledgePanel provides). From among this panel, we identified eligible respondents as having smoked at least 100 cigarettes in their lifetime, using at least 1 cigarette over the past 30 days, and purchasing cigarettes over the past 30 days.

We constructed our DCE using a balanced design (across levels) in accordance with good research practices in performing these types of experiments (37). This guideline recommends limiting DCE purchasing choice scenarios to 8 to 16 in order to avoid undue burden on participants (37). Therefore, respondents were randomly assigned 1 of 10 surveys, with each survey containing 12 out of 24 possible price/flavour/warning label choice scenarios. Our DCE has high *D*-efficiency of 98% compared to 100% that could be accomplished by asking about all 24 possible choices.

Our choice exercises were prefaced with the following: “if you were shopping for a tobacco/nicotine product and these were your only options, which would you choose.” Individuals were then presented with three items to choose from. The *first* is one pack of the individual’s regular cigarettes. The individuals’ preferred brand and price per pack was auto-populated from an earlier question, and respondents are reminded of the first Surgeon General cigarette warning label in Figure 1A. The *second* option is nicotine replacement therapy priced at \$6 for a package equivalent to a pack of cigarettes. Finally, the *third* option is a disposable ENDS, which was referred to as a *disposable vaping device* in the survey, with varying price (\$3, \$6, \$9), flavours (regular/menthol OR an expanded set of flavours including “tobacco, menthol, clove, spice, candy, fruit, chocolate, alcohol, and other sweets”), and one of four warning labels. Individuals could also proceed in the experiment without selecting either of the three options.

The ENDS warning labels used in this experiment are listed in Figure 1C. The first warning label option—no warning—represents the current federal warning label status for ENDS. The second warning label option is the proposed FDA warning label (17). The third warning label option is a modified risk statement that was originally proposed by a smokeless tobacco manufacturer RJ Reynolds in 2011 for their products (38), and more recently included in an application for a modified risk tobacco product (MRTP) for snus, a non-vaping smokeless product, by manufacturer Swedish Match (39, 40). Finally, the fourth

warning label option is the warning label on MarkTen e-cigarettes, which was voluntarily adopted by Nu Mark, an Altria Company (21).

The original sample of 1,200 respondents was reduced to 1,166 respondents without missing information on prior vaping experience, quit interest, cigarette price paid, income, and metro status. Each respondent completed 12 simulated choices, providing 13,992 choices, of which 40 were missing and subsequently dropped (including one person missing all 12 choices). Of the 1,165 respondents, we identified 145 individuals (12.5%) exhibiting intransitive preferences and exclude them from our primary analysis. A respondent's choices were considered inconsistent if they choose an ENDS in one simulation, but also choose cigarettes in a near-identical simulation except that ENDS became more attractive due to a lower price or an increase in their flavour availability. We did not consider risk message in deciding inconsistent preferences, except to hold it constant across choices to examine inconsistent preferences in price or flavours, because the risk messages are not necessarily an ordinal ranking. We perform a sensitivity analysis suggesting small effects of excluding non-transitive preference individuals. Our final sample is thus 1,020 individuals without missing information and making transitive choices.

Of our sample, 4.1% had never heard of ENDS, 32.3% had heard of them but have not used them, and 63.6% had used them at some point in the past. Lifetime e-cigarette use among current cigarette smokers was 55.7% in the 2012–2013 National Adult Tobacco Survey (41), so our slightly higher estimate of 63.6% may reflect increases in lifetime use between 2012–2013 and the end of 2014, or lifetime use of other types of ENDS devices than e-cigarettes.

Online Table 1 provides additional descriptive statistics. 17.5% of respondents used an ENDS in the last month. 17.4% had both tried quitting over the past year and used NRT in the last quit attempt, and 16.5% had tried quitting using a vaping device. On a scale of 1–10 for cigarette quitting interest (10 being the most interested), the mean response was 5.89. Respondents choose ENDS 13.5% of the time in the DCE. 78.3% of respondents took between 8–68 minutes to complete the survey. Respondents were not required to be complete the survey in one sitting, and 5.4% took longer than 24 hours to complete the survey. Roughly half the participants performed the survey in 2014 (47.0%) and the other half in 2015 (53.0%).

Empirical Strategy

We hypothesize that lower prices, higher availability of flavours, and less severe warnings (or no warning) will increase the likelihood of purchasing ENDS. To explore this, we estimate the following preliminary equation:

$$\begin{aligned} \text{ENDS PURCHASE}_{ic} = & \alpha + \beta_1 \text{ENDS PRICE}_{ic} \\ & + \beta_2 \text{ENDS FLAVOURS}_{ic} \\ & + \beta_3 \text{ENDS WARNING}_{ic} \\ & + X_i + \text{SURVEY CHAR}_i + \varepsilon, \end{aligned} \quad (1)$$

For individual i making simulated purchasing choice c , $\text{ENDS PURCHASE}_{ic}$ equals 1 if the individual purchases an ENDS, and is a 0 if they purchase either their usual cigarette product or a NRT product. We estimate a linear probability model for the probability of choosing the ENDS option as a function of indicator variables for each price level, flavour, and warning message. We control for individual socio-economic characteristics (above 24 years of age, gender, race/ethnicity, marriage status, education, income, labor participation, household size, metro area, and region), individual tobacco use characteristics (having above the median cigarette quitting interest, having vaped in the past month, having used NRT in last quit attempt, having used a vaping device in last quit attempt), and survey characteristics (if the individual completed the survey in 2015 and survey duration), and the price that individuals indicate usually paying for their preferred pack of cigarettes. Because each respondent provides multiple observations of their choices under different experimental conditions, we cluster standard errors at the level of individual (42).

In addition to using a linear probability model, we also explore the sensitivity of our results to using a standard logit model and an alternative-specific conditional logit model. The latter approach allows us to study characteristics of ENDS selection given the choice of two separate alternative products, cigarettes and NRT, rather than group these two products together as a non-ENDS selection.

We hypothesize important differences in how individuals respond to prices, flavour availability, and warning labels based on age, current use of vaping, and cigarette quitting interest. To explore these hypotheses, we expand equation (1) by interacting each policy variable (price, flavour availability, warning label) with being a young adult 18–24 years of age, using a vaping device in the past month, and having above the median cigarette quitting interest. This allows us to gauge differences in the effect of these policies on different types of adult smokers.

Results

In Table 1, we provide tabulations of the percent of respondents choosing an ENDS by price, flavour availability, and warning label. We stratify these results by age (panel A), cigarette quitting interest (panel B), and vaping over the past month (panel C). We stratify results by these characteristics because of our a priori hypothesis that regulatory policies have differential effects on these groups. In later results, we demonstrate statistically significant interactions between these groups and various regulatory options that justify this stratification.

All analyses show that ENDS prices are inversely related to ENDS selection. Younger adults selected an ENDS 34.4% of the time at a price level of \$3, 16.7% of the time at a price level of \$6, and 8.0% of the time at a price level of \$9. ENDS choices by older adults similarly declined as prices rose, from 18.3% at \$3 to 3.2% at \$9. For individuals with lower cigarette quitting interest, ENDS were chosen 16.6% of the time at a price of \$3 and 2.3% at a price level of \$9. ENDS were chosen more often among individuals at higher cigarette quitting interest, 34.3% at \$3 and 8.5% at a price level of \$9. For individuals that had not

used vaping devices in the past month, prices fell from 19.9% at \$3 to 3.6% at \$9, compared to 46.3% and 12.0% for individuals that had used vaping devices over the past month.

In all groups, respondents were least likely to choose ENDS with the MarkTen warning label ($p<0.001$). Additionally, in all groups, the FDA proposed warning label and modified risk warning label were not associated with reductions in ENDS product selection compared to not having a warning label.

We discovered interesting heterogeneity in how flavour availability influences purchasing of ENDS products. Increased flavour availability increased ENDS selection, from 17.5% to 21.9% for younger adults ($p<0.001$), but was not associated with a practically or statistically significant increase for older adults. Similarly, increased flavour availability increased ENDS selection ($p<0.001$) for individuals that have not used vaping devices in the past month, but was not associated with a statistically significant increase in ENDS selection for individuals that have. Regardless of cigarette quitting interest, both populations increased selection of ENDS products when more flavours were available.

We present linear probability model results for equation (1) on the left of Table 2. We find that increasing price is negatively associated with ENDS selection among adult smokers. They were 13.6 percentage points less likely to choose an ENDS at \$6 compared to \$3 ($p<0.001$), and 19.4 percentage points less likely to choose an ENDS at \$9 ($p<0.001$). Greater flavour availability was associated with a 2.1 percentage point increase in ENDS selection ($p<0.001$). A reduced risk warning label was not differentially associated with ENDS selection compared to no warning label, but the proposed FDA warning label was associated with a 1.1 percentage point reduction in ENDS selection ($p<0.05$) and the MarkTen warning label associated with a 5.1 percentage point reduction in ENDS selection ($p<0.001$). The MarkTen warning label has a larger effect than the FDA proposed warning label ($p<0.001$). Finally, being 18–24 years of age, having vaped in the past month, and having above the median cigarette quitting interest were associated with being more likely to choose an ENDS.

We present results for the interaction model on the right of Table 2. Young adults 18–24 years of age, smokers that have vaped over the last month, and smokers with above the median quitting interest were more price responsive than adult smokers 25 and older. Additionally, young adults were 3.7 percentage points more likely to choose ENDS when multiple flavours were available than older adults ($p<0.001$). Finally, young adult smokers were 2.9 percentage points less likely to choose an ENDS product with the MarkTen warning label compared to adult smokers 25 and older ($p<0.05$).

In Online Table 2, we demonstrate that results for equation (1) are substantially similar when we use a logit model and convert the coefficients to marginal effects. We use this model to estimate a price elasticity of -1.8 for the propensity to choose ENDS ($p<0.001$), which implies that a 10% increase in ENDS prices reduces ENDS selection by 18% for adult smokers.

In Table 3, we explore possible effects of New Year's resolutions to quit or reduce cigarette consumption, by comparing responses in December, 2014 to January, 2015. We find

evidence of New Year's resolutions influencing choices in our DCE. We hypothesize that adult smokers with the highest cigarette quitting interest would be most likely to make a New Year's resolution to quit or reduce smoking, and we find that cigarette choices declined by 8.3% from December 2014 to January 2015 for this population ($p<0.001$). In comparison, there was no statistically significant change in cigarette consumption for adult smokers with the lowest cigarette quitting interest. Adult smokers with the highest cigarette quitting interest were 24% more likely to choose ENDS in the New Year ($p<0.001$), suggesting that this may be a preferred substitute product over NRT, which only increased by a statistically insignificant 5.4%.

Table 3 also shows that younger adults may be more likely to make a smoking cessation resolution. The choice of cigarettes declined by 7.6% among younger adults in January 2015 ($p<0.001$), and was timed with a 29.7% increase in choices of ENDS ($p<0.001$). We did not observe any statistically significant differences among older adults.

We performed several sensitivity analyses. In unreported results, we found no evidence of order in which warning labels are presented to individuals through the 12 choices as having an independent influence on the choice of ENDS. Similarly, the number of times that individuals had previously viewed a given warning label had no independent effect. We also found that our results are robust to estimating equation (1) using an alternative-specific conditional logit model.

In Online Table 3, we re-estimate our regressions including responses from 145 individuals that we previously excluded for having inconsistent preferences. We find that our results for price and flavour availability are attenuated somewhat from Table 3 results, with estimates including non-transitive individuals suggesting a 17.5 percentage point reduction in the likelihood of purchasing ENDS at \$9 compared to \$3, whereas there was a more substantial 19.4 percentage point reduction in the likelihood when non-transitive individuals are excluded. However, our results are substantially similar regardless of including or excluding non-transitive respondents.

Discussion

In this paper, we contribute evidence on key questions faced by policymakers considering regulating ENDS by examining purchasing decisions made by adult smokers. Regulating these devices is complicated because consumers are not fully aware of the relative risks of cigarettes versus ENDS, and because ENDS have potential value as a harm reduction device.

The MarkTen warning label is associated with less frequent purchasing of ENDS, which is open to several interpretations. The MarkTen warning label is different from other explored warning labels by mentioning that the product is not a smoking cessation product and has not been tested as such, by identifying a group of vulnerable individuals that should not use the product, and by containing additional information on how nicotine is addictive and harmful. One interpretation is that the strong response to this warning in our DCE means that individuals might be unaware of these dangers. Another interpretation is that they might

be over-reacting and becoming overly pessimistic about ENDS. It is not clear if including the components of the MarkTen warning in the eventual FDA-CTP required warning label would lead to more or less accurate consumer perceptions of the relative risks of ENDS use versus smoking.

In navigating how to effectively regulate harmful aspects of ENDS while not limiting potential useful applications as harm reduction products, the FDA-CTP and other similar policymaking bodies may find it useful to reduce the appeal of these devices to adolescents. There is suggestive evidence that nicotine may be more harmful to adolescents (43) and adolescents are less likely to use these devices for smoking cessation/reduction purposes than adults (44). Adolescents are not in our study, but our findings that young adult smokers are influenced by ENDS flavours, whereas older adult smokers are not, suggests that removing flavour availability could have a relatively minor impact on adult smokers using ENDS (potentially for smoking cessation/reduction), but could have large impacts on the attractiveness of ENDS for adolescents. Therefore, an effective regulatory strategy may be to reduce flavour availability of ENDS to regular and menthol, similar to what has been done with cigarettes (26).

We find evidence that adult smokers are much less likely to purchase ENDS when the price is high, consistent with one other study (31). Taxing these products would be effective in reducing harms caused by these products, but would also limit their ability to provide harm reduction. A more effective regulatory strategy may be to provide additional information on harms of ENDS in warning labels and limit features more attractive to youth, such as flavours.

One limitation of our study is that we analyze disposable products rather than non-disposable products. However, we surveyed individuals after completing the DCE on whether the option of a disposable vaping device rather than a refillable vaping device would have changed their choices. Only 9% of respondents said that they would have been "much more likely" to choose the vaping device if it had been refillable instead of disposable. Current users of vaping devices were much more likely to feel this way (25.3%) compared to non-current users (6.0%). 63% said they would be about as likely or only somewhat more or somewhat less likely to choose a vaping device if it had been refillable. Therefore, this study limitation is mitigated due to the small number of individuals with strong preferences for refillable vaping devices.

A second limitation is that our study is based on survey responses in a DCE rather than on market observations. DCEs and other stated-preference surveys are widely used in economics and marketing (45). Many researchers conclude that the results of well-designed stated preference surveys are useful for policy-making (46), but others disagree (47). Our DCE provides evidence of external validity as our disposable ENDS price elasticity of -1.8 is not statistically different from a disposable price elasticity of -1.2 estimated using market data (31). Further, our results pass a number of internal validity checks (48), such as our coefficients meeting theoretical predictions and testing for non-transitive preferences.

A third limitation is that our study included only current smokers. Our study does not investigate the effect of policies on adults that only vape, for example, or adults that do neither but who may be open to “experimenting” with vaping. The effect of the product characteristics explored in this study may be different for these populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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A. Current Cigarette Warning Labels

- “SURGEON GENERAL’S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, and May Complicate Pregnancy”
- “SURGEON GENERAL’S WARNING: Quitting Smoking Now Greatly Reduces Serious Risks to Your Health”
- “SURGEON GENERAL’S WARNING: Smoking by Pregnant Women May Result in Fetal Injury, Premature Birth, and Low Birth Weight”
- “SURGEON GENERAL’S WARNING: Cigarette Smoke Contains Carbon Monoxide.”

B. Current Proposed Warning Label for ENDS

- “WARNING: This product contains nicotine derived from tobacco. Nicotine is an addictive chemical.”

C. Warning Labels Used in the Discrete Choice Experiment

1. **None**
2. **FDA:**
“WARNING: This product contains nicotine derived from tobacco. Nicotine is an addictive chemical.”
3. **Reduced Risk:**
“WARNING: No tobacco product is safe, but this product presents substantially lower risks to health than smoking cigarettes.”
4. **MarkTen:**
“WARNING: This product is not a smoking cessation product and has not been tested as such. This product is intended for use by persons of legal age or older, and not by children, women who are pregnant or breast-feeding, or persons with or at risk of heart disease, high blood pressure, diabetes, or taking medicine for depression or asthma. Nicotine is addictive and habit forming, and it is very toxic by inhalation, in contact with the skin, or if swallowed. Nicotine can increase your heart rate and blood pressure and cause dizziness, nausea, and stomach pain. Inhalation of this product may aggravate existing respiratory conditions. Ingestion of the non-vaporized concentrated ingredients in the cartridges can be poisonous. CA Proposition 65 Warning: This product contains nicotine, a chemical known to the state of California to cause birth defects or other reproductive harm.”

Figure 1.
Warning Labels

Table 1

A Percent of respondents choosing a disposable vaping device by price, flavours and warning label for respondents aged 18–24 and aged 25 or older

	Aged 18–24			Aged 25 or older		
	%	95% CI	p	%	95% CI	p
<i>Price</i>						
\$3	34.4			18.3		
\$6	16.7***	[−0.204, −0.150]	0.000	7.2***	[−0.126, −0.094]	0.0000
\$9	8.0***	[−0.291, −0.238]	0.000	3.2***	[−0.166, −0.134]	0.0000
<i>Warning label</i>						
None	22.5			10.6		
FDA	20.3	[−0.054, 0.010]	0.177	10.1	[−0.024, 0.013]	0.575
Reduced risks	20.9	[−0.049, 0.015]	0.304	10.9	[−0.016, 0.021]	0.790
MarkTen	15.1***	[−0.106, −0.042]	0.000	6.8***	[−0.057, −0.020]	0.000
<i>Flavours</i>						
Tobacco/menthol	17.5			9.2		
Many flavours	21.9***	[0.022, 0.067]	0.000	9.9	[−0.007, 0.020]	0.327

B Percent of respondents choosing a disposable vaping device by price, flavours and warning label for respondents having above or below median level of quit interest

	Quit interest low			Quit interest high		
	%	95% CI	p	%	95% CI	p
<i>Price</i>						
\$3	16.6			34.3		
\$6	5.8***	[−0.124, −0.092]	0.000	17.2***	[−0.196, −0.146]	0.000
\$9	2.3***	[−0.159, −0.128]	0.000	8.5***	[−0.283, −0.233]	0.000
<i>Warning label</i>						
None	9.8			22		
FDA	8.8	[−0.028, 0.009]	0.321	20.5	[−0.045, 0.015]	0.326

B Percent of respondents choosing a disposable vaping device by price, flavours and warning label for respondents having above or below median level of quit interest

	Quit interest low			Quit interest high		
	%	95% CI	p	%	95% CI	p
Reduced risks	8.8	[-0.028, 0.009]	0.297	22.1	[-0.029, 0.031]	0.957
MarkTen	5.7***	[-0.060, -0.023]	0.000	15.4***	[-0.096, -0.036]	0.000
<i>Flavours</i>						
Tobacco/menthol	7.5			18.6		
Many flavours	9*	[0.003, 0.029]	0.019	21.4**	[0.007, 0.050]	0.009

C Percent of respondents choosing a disposable vaping device by price, flavours and warning label for respondents having used or not used vaping devices in past month

	Not used vaping devices in past month			Used vaping devices in past month		
	%	95% CI	p	%	95% CI	p
<i>Price</i>						
\$3	19.9			46.3		
\$6	8.1***	[-0.132, -0.103]	0.000	23.9***	[-0.268, -0.180]	0.000
\$9	3.6***	[-0.177, -0.148]	0.000	12***	[-0.388, -0.300]	0.000
<i>Warning label</i>						
None	11.9			30.9		
FDA	11.2	[-0.024, 0.010]	0.431	27.3	[-0.089, 0.018]	0.192
Reduced risks	11.6	[-0.019, 0.014]	0.774	29.3	[-0.070, 0.037]	0.550
MarkTen	7.4***	[-0.061, -0.028]	0.000	22.1**	[-0.141, -0.034]	0.001
<i>Flavours</i>						
Tobacco/menthol	9.6			25.9		
Many flavours	11.5**	[0.007, 0.031]	0.002	28.9	[-0.007, 0.068]	0.115

Notes: All estimations are for respondents showing transitive behavior.

* p<0.05,

** p<0.01,

*** p<0.001

Table 2

Linear probability models of choice of disposable vaping devices

	Coefficient	95% Confidence interval	P-value	Coefficient	95% Confidence interval	P-value
Price: \$6	-0.136***	[-0.154, -0.118]	0.000	-0.074***	[-0.097, -0.052]	0.000
Price: \$9	-0.194***	[-0.215, -0.173]	0.000	-0.086***	[-0.112, -0.060]	0.000
Flavours: Many flavours	0.021***	[0.013, 0.029]	0.000	0.001	[-0.008, 0.010]	0.842
Warnings: FDA	-0.011*	[-0.021, -0.001]	0.026	-0.001	[-0.012, 0.010]	0.887
Warnings: Reduced risks	-0.004	[-0.013, 0.006]	0.448	-0.001	[-0.012, 0.010]	0.807
Warnings: MarkTen	-0.051***	[-0.064, -0.039]	0.000	-0.024***	[-0.038, -0.010]	0.001
Young adults	0.059**	[0.018, 0.100]	0.005	0.103***	[0.044, 0.162]	0.001
Used vaping in last month	0.126***	[0.081, 0.172]	0.000	0.223***	[0.149, 0.297]	0.000
Quit interest above median level	0.090***	[0.059, 0.120]	0.000	0.140***	[0.089, 0.190]	0.000
<i>Interactions</i>						
Price: \$6 × Young adults				-0.054**	[-0.093, -0.016]	0.005
Price: \$9 × Young adults				-0.093***	[-0.138, -0.049]	0.000
Price: \$6 × Used vaping in last month				-0.089**	[-0.146, -0.032]	0.002
Price: \$9 × Used vaping in last month				-0.150***	[-0.215, -0.085]	0.000
Price: \$6 × Quit interest above median level				-0.056**	[-0.093, -0.020]	0.002
Price: \$9 × Quit interest above median level				-0.103***	[-0.146, -0.061]	0.000
Flavours: Many flavours × Young adults				0.037***	[0.020, 0.055]	0.000
Flavours: Many flavours × Used vaping in last month				0.002	[-0.021, 0.026]	0.849
Flavours: Many flavours × Quit interest above median level				0.013	[-0.003, 0.029]	0.123
Warnings: FDA × Young adults				-0.011	[-0.034, 0.012]	0.350
Warnings: Reduced risks × Young adults				-0.015	[-0.037, 0.007]	0.175
Warnings: MarkTen × Young adults				-0.029*	[-0.058, -0.001]	0.046
Warnings: FDA × Used vaping in last month				-0.025	[-0.055, 0.005]	0.105
Warnings: Reduced risks × Used vaping in last month				-0.012	[-0.042, 0.019]	0.454
Warnings: MarkTen × Used vaping in last month				-0.035	[-0.076, 0.006]	0.097

	Coefficient	95% Confidence interval	P-value	Coefficient	95% Confidence interval	P-value
Warnings: FDA × Quit interest above median level				−0.003	[−0.023,0.017]	0.752
Warnings: Reduced risks × Quit interest above median level				0.013	[−0.007,0.032]	0.212
Warnings: MarkTen × Quit interest above median level				−0.022	[−0.048,0.004]	0.102
Survey Completion Characteristics		Yes			Yes	
Socio-Demographic Characteristics		Yes			Yes	
Tobacco Use Characteristics		Yes			Yes	
Geographic Region / Metro		Yes			Yes	
Observations		12,213			12,213	
Dep Var Mean		0.13			0.13	

Notes: Data from a DCE by UIC, Cornell, GfK. All estimations are for respondents showing transitive behavior. The reference categories for attribute variables are [\$3] for Price, [Tobacco/menthol] for Flavour, and [None] for Warning. The reference categories for the ENDS price interactions are the differentials for each subgroup at an ENDS price level of \$3. Standard errors are cluster-corrected at the individual level.

* p<0.05,

** p<0.01,

*** p<0.001

Table 3**A Percent of choices by interview year for respondents aged 18–24 and aged 25 or older**

	Aged 18–24			Aged 25 or older			
	2014	2015	Change <i>p</i>	2014	2015	Change <i>p</i>	
One pack of cigarettes	69.3	64.0	−7.6% ***	0.000	81.5	80.3	−1.5% 0.168
Nicotine replacement therapy	13.7	13.9	1.4%	0.856	9.1	9.9	8.8% 0.240
Disposable vaping device	17.0	22.0	29.7% ***	0.000	9.4	9.8	4.9% 0.505
Total	100	100		100	100		

B Percent of choices by interview year for respondents having above or below median level of quit interest

	Quit interest low			Quit interest high		
	2014	2015	Change <i>p</i>	2014	2015	Change <i>p</i>
One pack of cigarettes	87.7	86.2	–1.7% 0.074	63.6	58.4	–8.3% *** 0.000
Nicotine replacement therapy	4.7	4.7	–1.4% 0.901	18.6	19.6	5.4% 0.354
Disposable vaping device	7.6	9.1	20.3% * 0.023	17.7	22.0	24.0% *** 0.000
Total	100	100		100	100	

C Percent of choices by interview year for respondents having used or not used vaping devices in past month

	Not used vaping past month			Used vaping past month		
	2014	2015	Change <i>p</i>	2014	2015	Change <i>p</i>
One pack of cigarettes	80.1	76.0	–5.1% *** 0.000	65.5	60.3	–8.1% * 0.012
Nicotine replacement therapy	10.9	12.0	9.9% 0.091	9.3	9.9	6.1% 0.657
Disposable vaping device	9.0	12.0	33.7% *** 0.000	25.1	29.9	18.7% * 0.015
Total	100	100		100	100	

Notes: All estimations are for respondents showing transitive behavior and having started and finished the survey within the same year.

* $p < 0.05$,

*** $p < 0.01$,

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