Messaging about very low nicotine cigarettes (VLNCs) to influence policy attitudes, harm perceptions and smoking motivations: a discrete choice experiment

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Abstract

Background—To reduce smoking and the harms it causes, countries, including the USA, are considering policies to reduce nicotine in combustible tobacco to minimally addictive levels. Effective messages about very low nicotine cigarettes (VLNCs) and this policy are crucial in combating misperceptions threatening the policy’s effectiveness.

Data and methods—A discrete choice experiment assessed messages about VLNCs. Participants were 590 adults who smoked exclusively, 379 adults who both smoked and used

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e-cigarettes, 443 adults who formerly smoked and 351 young adults who never smoked (total n=1763). Seven message attributes were varied systematically (source, harm, chemicals, nicotine, satisfaction, addictiveness and quitting efficacy). Outcomes were selection of messages that generated the most positive attitude towards reduced nicotine policy, the greatest perceived harmfulness of VLNCs, and most strongly motivated quitting and initiating behaviour for VLNCs.

**Results**—Information about specific harms and chemicals of VLNCs had the largest effects on selection of messages as eliciting more negative attitudes towards VLNCs policy, increasing perceived VLNC harmfulness, increasing motivation to quit VLNCs and decreasing motivation to try VLNCs. Messages with information about quitting efficacy were selected as more motivating to quit among those who smoke, but also more motivating to try VLNCs among those who do not smoke.

**Conclusion**—Harm and chemical information can be prioritised to ensure VLNCs are not misperceived as less harmful than regular cigarettes. Messages about increased quitting efficacy and reduced addictiveness associated with VLNCs may backfire if presented to those who do not smoke.

**INTRODUCTION**

In 2018, The US Food and Drug Administration (FDA) issued an advanced notice of proposed rulemaking to limit nicotine content in combusted cigarettes to minimally or non-addictive levels,\(^1\) amounting to approximately a 95% reduction in nicotine concentration.\(^2\) In 2022, the US FDA announced plans to issue a proposed rule for a reduced nicotine standard.\(^3\) This policy is intended to minimise the levels of the chemical in cigarettes that causes smoking dependence,\(^4\)\(^5\) thereby helping people who smoke to quit more easily and keeping experimenters (primarily youth) from a lifetime of smoking. This policy has potential to substantially reduce smoking-related occurrence of lung disease, cancer and death\(^6\)–\(^8\) by preventing people who do not smoke from initiating and becoming addicted to smoking, as well as encouraging people who smoke to quit or adopt less harmful alternatives.\(^2\)\(^9\)–\(^11\) Meanwhile, New Zealand has announced plans to implement such a policy by 2025.\(^12\)

Maximising the positive impact of a reduced nicotine policy may depend on public acceptance and understanding of very low nicotine cigarettes (VLNCs), as prior research has raised concerns about the public reaction to such a policy.\(^13\)–\(^16\) Although a reduced nicotine policy confers multiple benefits, including reductions in smoking behaviour and substantially reduced mortality among the public,\(^9\)\(^17\)–\(^19\) numerous misperceptions persist among the public about the harmfulness, addictiveness and likely behavioural consequences of VLNCs,\(^20\) and these could reduce the full potential of the policy. For example, research shows that people incorrectly attribute smoking-related health harms to nicotine,\(^21\)–\(^24\) and about half of people who smoke incorrectly believe VLNCs are less carcinogenic than regular cigarettes.\(^13\) Qualitative research has also shown that some people who smoke are confused about nicotine’s role in addiction and believe that nicotine reduction will not reduce the addictiveness of cigarettes.\(^16\) Some people who smoke even believe that nicotine reduction will substantially *increase* smoking among current smokers via compensatory
behaviours (ie, smoking more to get the same levels of nicotine as from regular cigarettes),
cause relapse among former smokers and encourage non-smokers to try cigarettes.15

Misperceptions about VLNCs and reduced nicotine policy may be diminished through
messaging. Both empirical and theoretical literature indicate that effective messages can
influence motivations to try novel behaviours, including smoking, and therefore may
enhance the policy’s effect on quitting behaviour25 26 while conveying the harmfulness
of VLNCs and bolstering attitudes towards policies.27–30 In contrast, ineffective messages
about VLNCs may exacerbate negative reactions to the policy or generate additional
misperceptions, such as that VLNCs promote smoking among people who formerly smoked
and young adult non-smokers.31

The potential impact of such misperceptions highlights the importance of developing
effective VLNC messages, potentially containing multiple types of content. For example,
cues about the message source can influence beliefs and motivations32 33; in the context
of the reduced nicotine policy in the USA, the FDA is the relevant regulatory agency,1
and emphasising the FDA as the source of a reduced nicotine policy may influence
perceptions about the policy and VLNCs.34 35 The FDA is generally trusted among the
public but substantial distrust exists, especially among smokers,36 37 and the influence
of source characteristics in the context of VLNC messages remains uncertain. Second,
providing information about the harm of VLNCs can significantly improve the accuracy
of risk perceptions about VLNCs, especially when expressed as specific diseases caused
by smoking and specific harmful chemicals contained in cigarette smoke.13 38 Third,
content about ability to quit (self-efficacy) and reduced addictiveness of VLNCs may have
multiple impacts, such as cultivating positive attitudes towards the policy, but perhaps also
reducing the perceived harm of VLNCs due to their decreased addictiveness.14 Fourth,
information about reduced satisfaction from smoking VLNCs may decrease motivation to
smoke VLNCs39 40 by describing reductions in the psychoactive effects that people who
smoke often crave.41 Lastly, a specific description of the nicotine reduction (95%) may
elicit positive attitudes towards the policy42 but potentially reduce the perceived harm of
VLNCs,22 43 in part because nicotine is falsely perceived as the direct disease-causing
ingredient in cigarettes.

Research has yet to systematically test the effect of these multiple types of VLNC message
content on perceptions and behavioural intentions. Filling this gap, the present study
employs a discrete choice experiment (DCE) to estimate the impact of seven message
attributes on perceived message effectiveness regarding: (a) attitude towards a reduced
nicotine policy, (b) perceived harmfulness of VLNCs, (c) motivation to try VLNCs and (d)
motivation to quit smoking (see table 1 for descriptions message attributes and figure 1 for
example messages). DCEs control for and estimate the independent effect of each message
attribute.44
METHODS

Sample

Data were collected July–August 2021 using Ipsos KnowledgePanel, a probability-based web panel representative of non-institutionalised US adults. Only participants meeting the eligibility criteria based on smoking status and age were invited. Ipsos recruited four samples reflecting different relationships to smoking behaviour: (1) young adults aged 18–29 years who smoked fewer than 100 lifetime cigarettes; (2) adults who currently smoke and do not use e-cigarettes; (3) adults who formerly smoked; and (4) adults who currently smoke and use e-cigarettes. Eligibility was confirmed by self-reported questions in the survey. Initially, 6042 eligible adults were invited to participate, of whom 1483 completed the study. The KnowledgePanel sample consisted of 351 young adults who never smoked, 590 adults who smoked exclusively, 443 adults who previously smoked and 99 adults who smoked and used e-cigarettes. To augment the sample of people who used both products, 280 dual users were recruited from Toluna panel (convenience sample), bringing the total for this group to 379 and the total number of participants across groups to 1763. Ipsos generated study-specific poststratification survey weights to account for disparities in basic demographic characteristics resulting from recruitment and non-completion.

Prior DCEs in tobacco research have found a range of effect sizes. The current sample enables detection of small effect sizes with power ($\beta >0.80$).

Design and procedures

We conducted a DCE. DCEs have been frequently used and validated in public health research involving individual decisions or message evaluation. This study involved a within-subject fractional factorial design for seven message attributes, each with two levels ($2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$). Each message attribute represented the presence or absence of content about VLNC addictiveness, chemicals, craving satisfaction, the level of nicotine reduction, harmfulness and quitting efficacy. The seventh attribute represented the presence or absence of source information (FDA logo).

A balanced incomplete block design was used; 16 messages were selected such that all levels of all factors occurred an equal number of times (eight times), each level of each attribute co-occurred with each level of other factors an equal number of times (four times) and all factors were uncorrelated. The design used 20 choice sets, each with four messages (see figure 1). These sets were also balanced such that each message occurred five times, and each message co-occurred with every other message once. To reduce participant burden, these 20 choice sets were randomly assigned (without replacement) to one of two blocks, each containing 10 choice sets. The order of choice-set presentation was varied within each block using a Latin Square Design, and participants were randomly assigned to 1 of these 10 presentation sequences. To further reduce burden, participants were randomly assigned to two of three DCE task conditions in which they evaluated message effects on: (a) attitude towards the reduced nicotine policy, (b) perceived harm of VLNCs or (c) behavioural motivations in response to a reduced nicotine policy (motivation to quit for people who smoke; motivation to try for people who never or formerly smoked).
Before engaging in the DCE task, all participants were asked to ‘imagine a world where the nicotine in all cigarettes has been reduced’ and then instructed to evaluate ‘messages that would describe cigarettes in this world’. Then, the first of 10 choice sets, each with four messages, was shown in horizontal orientation along with the instructions for the task (see figure 1). Tasks elicited evaluations of message effectiveness. For the attitude task, participants indicated which message in the choice set would make them feel most positive and which would make them feel most negative about the reduced nicotine policy. For the perceived harm task, participants indicated which message would most make them think VLNCs were harmful and which message would least make them think VLNCs were harmful. The behavioural motivation task differed based on participants’ current smoking status; those who never or previously smoked indicated which message would most interest them and which would least interest them in trying cigarettes, while participants who smoked (those who smoked exclusively and those who both smoked and used e-cigarettes) indicated which message would most motivate them and which would least motivate them to quit smoking (see online supplemental appendix A). Task order was held constant with the attitude task first (if assigned), the risk perception task next (if assigned) and the behavioural motivation task last task (if assigned).

After completing each task, participants were asked whether the messages seemed meaningfully different (agree/disagree). If participants indicated no difference, they were considered ‘choice indifferent’ for that choice set. After tasks for a particular choice set were completed, participants evaluated the subsequent choice sets in their block in the same manner.

Analysis

The outcome for each task was dichotomised and recoded to indicate the evaluation was most positive/harmful/motivating (1) relative to others (0) in each choice set. Participants who indicated no difference between messages for every choice set (ie, choice indifferent participants) were excluded from the primary analysis for that outcome (see online supplemental appendix B for frequencies). For each outcome, $\chi^2$ tests assessed whether choice indifference was associated with user group or other demographic characteristics (see online supplemental appendix B). As part of model diagnostics and sensitivity analysis, results were obtained both including and excluding the choice-indifferent participants.

Separate conditional logistic models regressed each of the four outcome variables (attitude/harm perception/trying motivation/quitting motivation) on all message attributes, adjusting SEs for clustering within individuals and using poststratification weights. The block-assignment indicator was also included in the model to account for variation due to randomisation. To estimate the relative impact of each message attribute on the outcome variables, we calculated the ratio of each individual attribute’s effect to the total effect of all attributes per model estimates. Wald tests determined whether message effects differed significantly across the four user groups, with stratified analyses conducted by user group when results were statistically significant. Significance tests for primary DCE hypotheses were adjusted, controlling for the false discovery rate, wherein we reported significance based on a threshold of $p<0.01$. 

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RESULTS

Sample characteristics

Table 2 displays sample characteristics. The overall sample had slightly more males (52.3%) than females and was mostly white, with about 30% of participants identifying as racial/ethnic minorities; 43% had high school education or less.

Effects of VLNC message attributes

Table 3 displays regression model coefficients for each task (analytic samples; choice indifferent excluded). Direct effects for all tasks replicated the displayed results both with and without the choice-indifferent sample. Specifically, results did not differ in direction or significance for any estimate on account of including or excluding choice-indifferent participants.

For the attitude task, information about increased quitting efficacy, reduced addictiveness and the 95% nicotine reduction significantly increased the likelihood of participants selecting messages as promoting a positive attitude towards the policy. The presence of message content about both chemicals and harm decreased the likelihood of selecting messages as promoting positive attitude towards the policy. Figure 2 shows the relative effect sizes on attitude, wherein the four statistically significant message attributes explained choices to a similar extent (nicotine reduction: 23%, increased quitting efficacy: 22%, harm: 20%, chemicals: 18%).

For the perceived harm task, information about chemicals, harm, reduced satisfaction and the FDA logo increased the likelihood of participants selecting messages as promoting perceptions of VLNC harmfulness. As displayed in figure 2, the message attributes of chemicals (53%) and harm (38%) were overwhelmingly the strongest drivers of harm perceptions.

The behavioural motivation (to try) task included only young adults who never smoked and adults who previously smoked. As shown in table 3, describing chemicals and harms of VLNCs decreased the likelihood of participants selecting messages as motivating initiation of VLNC use, whereas describing addictiveness reduction and enhanced quitting efficacy increased the likelihood of selecting messages as motivating initiation of VLNC use. As displayed in figure 2, chemical (36%) and harm information (47%) were the most influential message attributes on motivation to initiate VLNC use.

The behavioural motivation (to quit) task included only adults who currently smoked exclusively and those who both smoked and used e-cigarettes. All message attributes increased the likelihood of participants selecting messages as motivating cessation, except the reduced addictiveness attribute. Figure 2 displays the relative strength of these effects; chemical (29%) and harm information (25%) were the most influential message attributes, followed by quitting efficacy increase (15%) and nicotine reduction information (12%).

Wald $\chi^2$ tests revealed no significant interactions (non-additive effects) between message attributes and user group for initiating behaviour, quitting behaviour and attitudes towards a
VLNC policy. For harm perceptions, however, the effect of addictiveness information varied significantly across user groups, $\chi^2(3)=11.83$, $p=0.008$. The stratified analyses showed, consistent with table 3, there was no significant effect of addictiveness information on harm perception, except among young adults who never smoked. For them, information about reduced addictiveness decreased the likelihood of selecting messages as promoting perceptions of VLNC harmfulness, OR=0.58, $p<0.001$.

**DISCUSSION**

The present study evaluated the impact of seven message attributes related to VLNCs to inform communication efforts that address misperceptions about VLNCs in the context of a reduced nicotine policy. Tobacco-use status did not generally impact message effects on attitude and harm perception but did impact message effects on behavioural motivation. Results showed that VLNC harm and chemical information were consistently among the most influential message attributes, especially for promoting risk perceptions and discouraging those who do not smoke from trying VLNCs. Portraying VLNCs as easier to quit and less addictive significantly increased interest in trying VLNCs among those who do not smoke (including former and never-smokers). Several message attributes increased behavioural motivation to quit smoking among those who smoke; these attributes included the FDA logo, chemical information, harm information, the specific nicotine reduction (95%), satisfaction reduction and quitting efficacy information. These results suggest that, in the context of a reduced nicotine policy, motivation to quit is potentially responsive to multiple messages that can be used simultaneously. Harm perceptions were dominated by harm and chemical information, but interestingly, the reduced satisfaction message attribute was also associated with perception of increased harm, as was the inclusion of the FDA logo. Attitude towards the reduced nicotine policy was also influenced by several message characteristics. Participants generally evaluated the policy more positively when VLNCs were described as increasing quitting efficacy, as less addictive and as containing 95% less nicotine. In contrast, describing VLNCs as still causing severe disease and containing harmful chemicals led to more negative evaluations of the policy.

**Implications for communicating about the VLNC policy**

VLNCs can promote smoking cessation or reduction, and universal reduction of nicotine in smoked tobacco products could lead to millions of lives saved through a reduction of smoking-induced disease. This possibility may depend in part on persons’ perception of VLNCs, and the full benefits of a reduced nicotine policy may be dampened if misperceptions are not corrected. The present study suggests how messages about VLNCs may enhance the effectiveness of the policy by increasing motivation to quit among those who smoke.

Policymakers should also consider differences in message responses between those who do and do not smoke, which were most notable in terms of behavioural motivation. Messages about quitting efficacy appeared to increase motivation to quit smoking among those who smoke; however, the same message was perceived as increasing motivation to try VLNCs among those who do not smoke. Among young adult non-smokers, portraying VLNCs
as non-addictive also led to reduced evaluations of the harmfulness of VLNCs. Despite the potential for an increase in experimentation with VLNCs, the reduction of chemical dependency should ultimately reduce chronic smoking behaviour. Furthermore, research has shown that, within the last decade, people who do not smoke, including youth, are generally uninterested in trying cigarettes, although they often lack information about these products. Importantly, messages aimed at those who do not smoke may best avoid describing benefits of VLNCs. In any case, messages about VLNCs should emphasise that VLNCs are as harmful as regular cigarettes and contain the same amount of all the other harmful chemicals besides nicotine. This might help correct common misperceptions about the role of nicotine in causing disease.

Public perceptions of the FDA’s scientific accuracy and integrity may influence how the policy is construed, or even the level of opposition against such a policy. VLNC communication strategies may be strengthened by integrating source information. Prior research has shown that the public is generally uninformed about the role of the FDA in tobacco regulation but that those who smoke, despite scepticism, still find the FDA to be generally trustworthy. In the current study, including the FDA logo in messages increased motivation to quit and, for the entire sample, increased perceived harmfulness of VLNCs. These findings suggest that source information along with harm information may help combat misperceptions that VLNCs are less harmful.

**Implications for research**

Emerging research has begun to develop messages about VLNCs and reduced nicotine policy, but studies have focused on effects of single messages, mostly addressing the amount of nicotine reduction or health effects of VLNCs. The present study extends this body of work by combining several kinds of message content in a DCE to allow a direct comparison of effectiveness in terms of policy attitudes, perceived harms of VLNCs, and quitting or initiating behaviour. Future research can include measures of smoking behaviour, particularly as a reduced nicotine policy begins to be implemented. Behaviour of interest may include cessation or reduction, initiating or increasing, or switching between products. In this way, research may continuously monitor the consequences of the policy and the ability of messaging strategies to positively impact its success.

As a reduced nicotine policy approaches implementation in the USA, public opinion may become increasingly relevant. Evidence generally supports the policy’s benefits of reducing cigarette addiction in the long run and promoting less harmful alternatives among current smokers; nonetheless, although public support is generally favourable, a substantial minority of smokers oppose the policy (estimates range from about 20–40%). The present study highlights some messaging strategies that may best assuage concerns. Interestingly, the need to combat misperceptions about the harmfulness of VLNCs may be at odds with promoting the policy, as emphasising this point reduced message effectiveness to promote policy attitudes.

The present results are consistent with the research finding strong impacts of fear-inducing messages. We observed that information about harms of—and chemicals in—VLNCs had consistently large effects for each outcome. Perceived risks can prompt
strong responses, cognitively, emotionally and behaviorally. In the present study, risk information more strongly motivated people who do not smoke to avoid VLNCs than it motivated people who are smokers to quit. In general, smoking behaviour is associated with elevated risk tolerance and optimism bias. Future research may further explain differential sensitivity to risk information between those who do and do not smoke, which may allow better message tailoring in general.

The potential for VLNCs to promote experimentation with cigarettes illustrates the role of perceived quitting efficacy and autonomy in behavioural choices and preferences. Eliminating the risk of addiction may make cigarettes more attractive to those who do not smoke, at least for initial use. This may promote perceptions that experimentation with cigarettes no longer carries risk of addiction, and people may see themselves as free to stop and start smoking without developing dependency or needing to identify as a smoker. We identified no studies reporting the extent that social or psychological influences could lead to chronic smoking behaviour in the absence of chemical dependency. Research in other contexts, however, has shown the potentially self-reinforcing effect of behvaiour.

Pending adoption of a reduced nicotine policy, research could investigate these factors, such as cognitive consistency and identity formation.

The observed effect that satisfaction-reduction messages increased perceived harmfulness of VLNCs may appear surprising; satisfaction from smoking is not directly related to the physical harm caused by the behaviour. Nonetheless, the finding is consistent with literature on the affect heuristic. For VLNCs, the negative information about reduced satisfaction might serve to inform judgements of risk on an emotional level. Future research can determine which sets of perceived VLNC features tend to be linked so that messaging can leverage attitude networks to influence general attitudes and behaviour.

**Limitations**

The present results should be considered along with some limitations. First, the DCE tasks used in this study involved hypothetical scenarios, some of which required participants to predict future (unrealised) events. In some cases, people may misperceive their future behaviours, and there may be inconsistency between motivation and subsequent action. Despite this limitation, prior research has shown that DCEs are generally consistent with choices made across a variety of real-life situations and provide generally accurate estimates. Moreover, the use of a DCE enabled simultaneous estimation of the independent effects of seven message features, although these effects should be further tested in randomised controlled trails with longitudinal behavioural assessments. The lack of behavioural measures has been an ongoing limitation of studies on VLNC messaging.

In addition, the present study focused on the general effects of message attributes but did not address differential responses associated with participant characteristics, such as psychological traits or baseline trust in FDA. This may partially explain the mixed results for message–source information (FDA logo) across outcomes assessed; there may be individual differences in responses to the FDA logo. For example, people who believe the FDA lacks credibility may evaluate the policy more negatively if messages identify the FDA as the source (consistent with research on source credibility effects). Future research
should examine individual differences in responses to source information and other message attributes. Nonetheless, the use of a randomised experimental design means individual differences do not confound the results for message attributes in general.

The present study included participant samples of those who currently smoke, those who previously smoked, young adults who did not smoke and those who both smoked and used e-cigarettes. However, the dual-use individuals proved difficult to recruit from the nationally representative panel. As a result, this sample was supplemented by a non-representative convenience sample. This limits the generalisability of the results to that population. As innovations in nicotine delivery systems continue, and as patterns of adoption change, communication research should continue to sample distinct populations of user groups who may respond differently to messages due to their contrasting experiences with tobacco products.

CONCLUSION

Successful implementation of a VLNC policy may be encumbered by prevalent misperceptions about VLNCs. The present study tested several features of messages communicating about VLNCs. Specifically, this study showed the large impact of harm and chemical information relative to other message content. In addition, messages about the increased quitting efficacy from VLNCs bolster quitting motivations among those who smoke but also increase motivations to try VLNCs among those who do not smoke. This suggests that positive attributes of VLNCs should be conveyed cautiously to people who do not smoke, but information about harms of VLNCs could be effective across all user groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability statement

Data are available on reasonable request.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

- The public misperceives the harmfulness, addictiveness and behavioural consequences of very low nicotine cigarettes (VLNCs).

WHAT THIS STUDY ADDS

- Information about specific harms and chemicals were the most influential message attributes and were perceived to amplify risk perceptions, encourage quitting and discourage trying VLNCs.
- Portraying VLNCs as easier to quit and less addictive was perceived to increase interest in trying VLNCs among those who do not smoke, including people who never smoked and who used to smoke.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- Effective messaging can influence policy attitudes, risk perception and behavioural motivation regarding VLNCs.
- Audience characteristics should be considered, especially when describing positive attributes of VLNCs.
- Information on harms of VLNCs appear most influential in preventing adoption by non-smoking adults.
Figure 1.
Example choice set for VLNC message DCE. DCE, discrete choice experiment; VLNC, very low nicotine cigarette.
Figure 2. Relative importance of VLNC message features for each DCE task. Note: *$p < 0.01$.
The quitting behaviour motivation task involved only people who were current smokers, including dual-users. The trying behaviour motivation task involved only people who formerly smoked and young adult never-smokers. DCE, discrete choice experiment; VLNC, very low nicotine cigarette.
Table 1

VLNC message attributes

| Message feature       | Content                                                                 |
|-----------------------|--------------------------------------------------------------------------|
| Source information    | FDA logo                                                                 |
| Chemicals             | ‘They still have harmful chemicals like formaldehyde and arsenic’        |
| Harm                  | ‘They still cause lung cancer and death’                                 |
| Nicotine reduced      | ‘Nicotine levels have been reduced by 95%’                               |
| Satisfaction reduced  | ‘They are now less satisfying’                                           |
| Addictiveness reduced | ‘They are now minimally or non-addictive’                                |
| Quitting efficacy increased | ‘You can quit more easily’                                           |

FDA, Food and Drug Administration; VLNC, very low nicotine cigarette.
Table 2

Descriptive statistics

|                                | Total sample (n=1763) |
|--------------------------------|-----------------------|
| Age, years (M (SD))            | 44.1 (17.6)           |
| Sex (%)                        |                       |
| Male                           | 52.3                  |
| Female                         | 47.7                  |
| Race/ethnicity (%)             |                       |
| Non-Hispanic white             | 70.7                  |
| Non-Hispanic black             | 10.2                  |
| Hispanic                       | 12.8                  |
| Other                          | 6.3                   |
| Education (%)                  |                       |
| Less than high school          | 10.3                  |
| High school                    | 33.0                  |
| Some college                   | 37.5                  |
| Bachelor’s degree or higher    | 19.2                  |
| Tobacco use status (%)         |                       |
| Exclusive smoking              | 33.5                  |
| Smoking and use of e-cigarettes| 21.5                  |
| Previous smoking               | 25.1                  |
| Young adult not smoking        | 19.9                  |

Note: n=1763. Survey weights were used to adjust all estimates except tobacco use status.
Table 3

VLNC message attribute effects

| Source information                        | DCE task odds ratios (99% CI)                                                                 |
|-------------------------------------------|---------------------------------------------------------------------------------------------|
|                                           | Attitude toward reduced nicotine policy | Perceived harm of VLNCs | Behavioural motivation (to try) | Behavioural motivation (to quit) |
| FDA logo                                  | 1.08 (0.92 to 1.25) | 1.47 (1.20 to 1.80) | 1.39 (0.89 to 2.17) | 1.36 (1.03, 1.79) |
| Chemicals                                 | 0.55 (0.46 to 0.66) | 8.22 (6.11 to 11.06) | 0.16 (0.10 to 0.24) | 2.83 (1.98, 4.08) |
| 'They still have harmful chemicals like formaldehyde and arsenic' |                                           |                            |                        |                      |
| Harm                                      | 0.52 (0.42 to 0.66) | 6.12 (4.65 to 8.06) | 0.13 (0.08 to 0.20) | 2.54 (1.74, 3.70) |
| 'They still cause lung cancer and death'  |                                           |                            |                        |                      |
| Nicotine reduced                          | 2.08 (1.75 to 2.48) | 1.16 (0.96 to 1.40) | 1.01 (0.66 to 1.55) | 1.75 (1.30, 2.36) |
| 'Nicotine levels have been reduced by 95%' |                                           |                            |                        |                      |
| Satisfaction reduced                      | 1.03 (0.90 to 1.19) | 1.38 (1.13 to 1.68) | 0.72 (0.47 to 1.11) | 1.46 (1.13, 1.88) |
| 'They are now less satisfying'            |                                           |                            |                        |                      |
| Addictiveness reduced                     | 1.67 (1.44 to 1.95) | 0.95 (0.78 to 1.16) | 2.01 (1.36 to 2.97) | 1.35 (0.91, 2.00) |
| 'They are now minimally or non-addictive' |                                           |                            |                        |                      |
| Quitting efficacy increased               | 1.99 (1.67 to 2.37) | 0.90 (0.73 to 1.10) | 1.68 (1.33 to 2.13) | 1.93 (1.38, 2.60) |
| 'You can quit more easily'                |                                           |                            |                        |                      |
| Overall model p value (Wald $\chi^2$)     | <0.001                                      | <0.001                      | <0.001                  | <0.001               |

Sample size

| Persons | 765 | 727 | 297 | 372 |
|---------|-----|-----|-----|-----|
| Choice sets | 4915 | 4835 | 2023 | 2243 |
| Choices  | 19 660 | 19 340 | 8092 | 8972 |

Note: model coefficients were estimated using conditional logistic regression, and SEs were adjusted for the clustered data structure (choices within choice-sets within persons within blocks). The behavioural motivation (to try) task included young adults who never smoked and adults who previously smoked. The behavioural motivation (quitting) task included adults who currently smoked exclusively and those who both smoked and used e-cigarettes; model estimates were survey-weight adjusted.

* Significant after correcting for false-discovery rate.

DCE, discrete choice experiment; VLNC, very low nicotine cigarette.