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ORIGINAL ARTICLE

E-cigarette, heated tobacco, and cigarette preferences among Canadian e-cigarette users and nonusers: A discrete choice experiment

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Abstract

Objective The rapid increase in the use of e-cigarettes may facilitate the cessation of tobacco use, but may also introduce a new pathway to becoming addicted to nicotine. Our objective was to examine how e-cigarette users and young nonusers respond to product characteristics.

Methods We conducted a discrete choice experiment that included choices over three products (vape pods, heated tobacco sticks, cigarettes) with four attributes: on-product health warnings, plain packaging for vape pods, nicotine concentration allowable in vape pods, and price, among residents of Alberta, Ontario, and Québec. Conditional logit regressions were used to estimate the relative effects that differing attribute levels had on respondents choosing a product they would most likely buy (or try if nonusers) and the product they believed would pose the least risk to their health.

Results Relative to the weakest policies (i.e., no on-product warnings, branding on vape pod packaging, no restrictions on nicotine concentration, and lower prices), respondents preferred options without on-product warnings, lower prices, and lower nicotine concentration in vapes. On-product warnings were particularly salient and appeared to work synergistically. Among nonusers and users, a warning on all three products increased the predicted probability (Pr) of choosing 'none' from Pr 0.50 (95% CI 0.47, 0.53) to Pr 0.65 (95% CI 0.63, 0.68) and from Pr 0.10 (95% CI 0.09, 0.12) to Pr 0.18 (95% CI 0.16, 0.21), respectively.

Conclusion On-product warnings (separate from traditional warnings on the package) may reduce experimentation and use of e-cigarettes and cigarettes, while higher prices may reduce use.

Résumé

Objectif L'augmentation rapide de la prévalence d'usage de la cigarette électronique pourrait faciliter le renoncement au tabac, mais aussi ouvrir une nouvelle voie vers la dépendance à la nicotine. Notre objectif était d'examiner comment les utilisateurs de cigarettes électroniques et les jeunes non-utilisateurs réagissent aux caractéristiques des produits.

Méthodes Nous avons mené une expérience de choix discrets auprès de résidents de l'Alberta, de l'Ontario et du Québec, à qui l'on présentait trois produits (capsules de vapotage, bâtonnets de tabac chauffé et cigarettes combustibles). Ces produits différaient selon quatre attributs : des mises en garde sanitaires directement sur les produits, l'emballage neutre des capsules

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de vapotage, la concentration de nicotine autorisée dans les capsules et le prix. Des régressions logit conditionnelles ont été réalisées pour estimer les effets relatifs de ces attributs sur le choix. Les répondants indiquaient le produit qu'ils seraient le plus susceptibles d'acheter (ou d'essayer, s'ils n'étaient pas utilisateurs) et celui qui présentait le risque le plus faible pour leur santé.

Résultats Comparativement au niveau le plus faible des mesures (c.-à-d. absence de mise en garde sanitaire sur le produit, présence de la marque sur l'emballage des capsules de vapotage, aucune restriction sur la concentration en nicotine et prix plus bas), les répondants ont privilégié les options sans mise en garde, avec des prix plus bas et une concentration en nicotine plus faible dans les capsules de vapotage. Les mises en garde sanitaires apposées directement sur les produits étaient particulièrement marquantes et semblaient agir en synergie. La présence d'une mise en garde sanitaire sur les trois produits augmentait la probabilité prédite (Pr) de choisir l'option « aucun» de 0,50 (IC à 95% : 0,47; 0,53) à 0,65 (IC à 95% : 0,63; 0,68) chez les non-utilisateurs et de 0,10 (IC à 95% : 0,09; 0,12) à 0,18 (IC à 95% : 0,16; 0,21) chez les utilisateurs.

Conclusion Les mises en garde sanitaires apposées directement sur les produits plutôt que sur leur emballage et simultanément sur les trois produits pourraient réduire l'expérimentation à l'usage des cigarettes électroniques et des cigarettes, tandis que des prix plus élevés pourraient en réduire la consommation.

Keywords Tobacco · Cigarette smoking · Electronic nicotine delivery systems · Vaping · Product packaging · Product labeling · Price · Discrete choice experiment · Stated preferences · Alberta · Ontario · Québec · Canada

Mots-clés Tabac · Tabagisme · Inhalateurs électroniques de nicotine · Vapotage · Emballage des produits · Étiquetage des produits · Prix · Expérience de choix discrets · Préférence déclarée · Alberta · Ontario · Québec · Canada

Introduction

Tobacco use has long been known to cause poor health and is widely recognized as the leading cause of preventable death (GBD 2019 Tobacco Collaborators, 2021; US Department of Health & Human Services, 2014). Globally, in 2019, it is estimated that 7.7 million deaths were attributable to tobacco use (GBD 2019 Tobacco Collaborators, 2021). In Canada, despite a substantial decline, cigarette use remains relatively high (Statistics Canada, 2024). The rapid increase in the use of e-cigarettes (e.g., vapes) and heated tobacco products may facilitate the cessation of combustible tobacco use, but it may also introduce a new pathway to becoming addicted to nicotine. E-cigarettes have recently surged in popularity in many countries, including Canada and the United States (US) (Cantrell et al., 2018; Filippidis et al., 2017; Hammond & Reid, 2025; Hammond et al., 2019; Kmietowicz, 2014; Royal College of Physicians, 2024; Sreeramareddy et al., 2024). It is generally accepted that e-cigarettes and heated tobacco products are safer alternatives to combustible cigarette smoking, but the extent of the reduction in harm is still debated (National Academies of Sciences 2018; Fairchild et al., 2019; Royal College of Physicians, 2024).

In Canada, the introduction of the Tobacco and Vaping Products Act in 2018 legalized the sale of e-cigarettes and heated tobacco products for adults. Survey estimates suggest that use among youth has significantly increased since (Canada, 2015, 2019), with about a third of Canadian youth reporting having used e-cigarettes in the last 30 days (Health Canada, 2024).

The popularity of e-cigarettes among youth has led some provincial governments to strengthen regulations. For example, in 2015, Québec applied the same regulation to e-cigarettes as for tobacco products, including a ban on all forms of promotion and advertising, including displays at point-of-sales accessible to minors and promotion on social media, and the prohibition of online sales (Éditeur officiel du Québec, 2020). At the federal level, Canada introduced in 2021 a limit of 20 mg/mL of the nicotine concentration allowed in e-cigarettes in line with similar regulations in the European Union in effect since 2014 (European Parliament and Council of the European Union, 2014; Government of Canada, 2021).

There is substantial evidence that taxes that raise the price of tobacco products reduce tobacco use, save lives, and increase government tax revenue (International Agency for Research on Cancer, 2011; U.S. National Cancer Institute and World Health Organization, 2016). The evidence pertaining to e-cigarettes and heated tobacco products is, however, more mixed (Belon et al., 2025; Glasser et al., 2017; Reiter et al., 2024; Selya et al., 2023; Yan et al., 2023). In Canada, currently, there are three broad product categories with implications for taxation policies: (i) electronic vaping products; (ii) heat-not-burn products; and (iii) traditional tobacco products such as cigarettes. Heated tobacco products fall under the broad federal excise tax category "manufactured tobacco other than cigarettes and tobacco sticks" alongside combustible products. Unlike tobacco products, additional specific taxes have been imposed on e-cigarettes only recently. British Columbia was the first province to act

in 2020 (Physicians for a Smoke-Free Canada, 2024). At the federal level, a tax on e-cigarettes came into effect in 2022, and provinces and territories were invited to participate in a coordinated federal-provincial/territorial tax system. Ontario, Québec, the Northwest Territories, and Nunavut joined in 2024 (Physicians for a Smoke-Free Canada, 2024).

Another important policy intervention for cigarettes has been the introduction of plain and standardized packaging. In 2019, Canada became the country with the most comprehensive cigarette packaging regulations. The regulations, which apply to all tobacco products, including heated products but not e-cigarettes, include provisions such as prohibiting brand colours, graphics, and logos on packages, requiring a drab brown colour to appear as the base colour for all brands, requiring cigarette packages to be in a standardized slide and shell format, thus increasing warning size, and requiring the largest health warnings on cigarette packages in the world in terms of surface area (Canadian Cancer Society, 2019; Government of Canada, 2019). In 2022, Canada announced its intention to require that individual cigarette sticks carry health warnings, the first jurisdiction to ever do so (Government of Canada, 2022). By July 31, 2024, all cigarettes were required to carry one of six rotated bilingual warnings. Effective July 1, 2025, Australia became the second jurisdiction to require on-product health messages (Australian Government, 2025a, b).

The rapidly changing policy landscape makes it difficult to use standard empirical approaches such as quasi-experimental designs to examine the effect of policy changes on use intentions, purchase decisions, and risk perceptions. Additionally, promising policies such as on-product messages for e-cigarettes and heated tobacco products have not been implemented in Canada.

Our primary research aim was to contribute experimental evidence to inform policy decisions about the effects of, and trade-offs between (1) on-product warnings; (2) plain packaging; (3) maximum nicotine strength; and (4) prices. We conducted a stated preference discrete choice experiment in three Canadian provinces (Alberta, Ontario, and Québec) and examined intention to try (among young nonusers), intention to purchase (among users), and risk perceptions (among nonusers and users).

Methods

Study sample

The participants were recruited from LeoOpinion, a commercial online panel owned and managed by Léger, the largest Canadian-owned market research company. Incentives to complete the survey were provided by Léger in the form of points which could be redeemed for rewards and chances of entering monthly contests. A total of 1839 young (16–29 years) nonusers and 1122 users (respondents who reported having used e-cigarettes in the past 30 days) completed the online survey (nonusers, November–December 2021; users, April–May 2022).

Questionnaire development

The survey instruments were informed by a scoping review of studies that used stated preference experimental approaches to examine plain/standardized packaging, warnings on cigarette sticks, or prices, and a discrete choice experiment that examined cigarette packaging, on-product warnings, prices, and illicit cigarettes among smokers in Ontario, Canada (Guindon et al., 2024). Draft questionnaires were piloted among 28 students and staff of McMaster University. The questionnaires were subsequently translated into French.

Outcomes

Among current users of e-cigarettes, we examined their intention to purchase from a choice set of 2 or 3 alternative nicotine and tobacco products: "If these were the only options you had to choose from, which would you be most likely to buy?" Respondents were instructed that "choosing 'none' implies that you would choose not to vape or smoke. For example, if you vape about 4 JUUL pods per week, selecting 'none' means that you would prefer not to vape or smoke for a week rather than buying any of the three packs shown. Similarly, if you smoke a pack of 25 cigarettes a day, selecting 'none' means that you would prefer not to smoke or vape for a day rather than buying any of the three packs shown." Among young nonusers, we examined their intention to try: "If these were the only options you had to choose from, which option would be most likely to encourage someone like you to try e-cigarettes or cigarettes?" We also examined risk perception among both users and nonusers: "Which of these do you think would pose the least risk to your health?"

Products and attributes

We examined three products that were affected differently by regulations (vapes, heated tobacco, and cigarettes) and four attributes: on-product warnings, plain packaging, maximum nicotine concentration, and prices. To keep our experiment as realistic as possible, we focused on the most popular brands for each product category, at the time of the experiment (JUUL, vapes; IQOS, heated tobacco; du Maurier, cigarettes).

Respondents were instructed as follows: "When making your choice, assume that you own the device shown. The

prices listed for JUUL and IQOS are for the pods (pack of 4) and Heets (pack of 50) and NOT for the devices. Note that a pack of 4 JUUL pods is roughly equivalent to 3 packs of 25 cigarettes; and that one Heet stick is roughly equivalent to one cigarette."

For each attribute, we varied the following levels:

- on-product warnings, with vs without;
- packaging (vapes only), plain packaging vs current packaging with branding;
- nicotine concentration (vapes only), high (5%) vs low (1.5%);
- prices, current prices vs ↑ 20% vs ↑ 40% (JUUL pods, pack of 4 pods: $23.75, $28.50, $33.25; IQOS Heets Elm, pack of 50 sticks: $26.00, $31.20, $36.40; and, du Maurier, pack of 25: $16.50, $19.80, $23.10; all $ are Can$ [at the time of the survey, Can$1 was approximately equivalent to US$0.77]).

With the exception of limits on nicotine concentration, we did not include any 'weaker' attribute levels that had already been legislated (e.g., branding on heated tobacco or cigarette packs).

Experimental design and statistical analysis

We used a *D*-efficient fractional factorial availability cross-effect design that allows the estimation of main effects, some two-way interactions and cross-effects. Adding an extra level (e.g., 'zero' to indicate absence) in an alternative-specific variable, availability cross-effect designs present only a fraction of alternatives in each choice set and evaluate the effect of the presence/absence of an alternative on the utility of another alternative (Lazari & Anderson, 1994). The effects of packaging, on-product warnings, and nicotine concentration were modelled as binary variables, while prices were modelled as continuous variables. The design was generated using Ngene 1.2 (ChoiceMetrics, 2025) and resulted in 48 choice sets of two or three alternatives with an opt-out (administered in four blocks of 12 choice sets to minimize response burden). Figure 1 presents choice set examples. The survey instruments are available in Supplement 1.

We used conditional logit regressions to estimate parameters. Estimated coefficients represent the effect of the respective attribute level had on respondents' preferences for an alternative to possessing that feature. To ease interpretation, we calculated predicted probabilities following estimations. We explored heterogeneity in preferences by analysing separately females and males, respondents with lower (< $60,000) and higher (≥ $60,000) household income, residents of Alberta, Ontario, and Québec, dual users, e-cigarette users and former cigarette users and sole e-cigarette users, users who had, or had not, stopped using e-cigarettes for one or more days in the past 12 months because they were trying to quit, and nonusers who were < and ≥ 25 years. Lastly, we examined if removing low-quality respondents affected our main findings (eTable 1 in supplement 3). All analyses were conducted using Stata/MP 18.5.

Results

The characteristics of the samples of nonusers and users are presented in eTables 2 and 3 in supplement 3. There were minor differences in characteristics of respondents across the three provinces, generally found in education level, racial identity, and household income. Among nonusers and users, 25% and 46% were male, 67% and 73% identified as white, 14% and 16% were landed immigrants, 40% and 37% had at least a bachelor's degree, 40% and 65% reported that compared with cigarettes, and e-cigarettes with nicotine were much less or somewhat less harmful than cigarettes. Nonusers had a mean age of 24 years, 22% reported ever using e-cigarettes, and 7% currently used cigarettes. Users had a mean age of 36 years, 51% were dual users, 30% were former cigarette users, and 31% reported JUUL as their usual e-cigarette brand.

Tables 1 and 2 and eTables 4 to 25 in supplement 3 present predicted probabilities from the results of the conditional logit regressions; Figs. 2 and 3 and eFigures 1 to 45 in supplement 4 provide a visual depiction. The status quo scenario represents the weakest policy context (i.e., no on-product warnings, branding on vape pod packaging, no restrictions on nicotine concentration [represented by high nicotine strength in vape pods], and the lowest prices).

Intention to try among nonusers

Using status quo policy levels as a reference point, the average nonuser in our sample had a 0.50 (95% CI 0.47, 0.53) predicted probability of choosing 'none', followed by vape pods (0.37 [95% CI 0.34, 0.40]), heated tobacco sticks (0.07 [95% CI 0.06, 0.08]), and cigarettes (0.06 [95% CI 0.05, 0.07]).

Introducing on-product warnings decreased the predicted probabilities of choosing each product, with a combined effect of increasing the predicted probability of choosing 'none' by 15 percentage points to 0.65 (95% CI 0.63, 0.68). Lower nicotine strength increased the predicted probability of choosing vaping pods by five percentage points to 0.42 (95% CI 0.39, 0.45).

Removing branding on vape pod packaging and higher prices did not appreciably change preferences. Preferences

A	B	C
JUULpods, Mint high nicotine strength, 5% Pack of 4 pods	IQOS Heets Elm Pack of 50	du Maurier cigarettes Pack of 25
		
$33.25	$31.20	$23.10

A	B
JUULpods, Mint high nicotine strength, 5% Pack of 4 pods	IQOS Heets Elm Pack of 50
	
$23.75	$36.40

Fig. 1 Choice sets examples

Table 1 Results: intentions to try and purchase (predicted probabilities)

Products	Vape pods		Heated tobacco		Cigarettes		None	
Product attributes	Pr	95% CI	Pr	95% CI	Pr	95% CI	Pr	95% CI
– Intention to try, nonusers								
Status quo	0.37	0.34, 0.40	0.07	0.06, 0.08	0.06	0.05, 0.07	0.50	0.47, 0.53
On-product warnings								
Vape pods	0.30	0.27, 0.32	0.07	0.06, 0.08	0.06	0.05, 0.07	0.57	0.55, 0.60
Heated tobacco	0.35	0.32, 0.37	0.06	0.05, 0.07	0.05	0.04, 0.07	0.54	0.51, 0.57
Cigarettes	0.34	0.31, 0.36	0.07	0.06, 0.08	0.05	0.04, 0.05	0.55	0.52, 0.58
All	0.25	0.23, 0.27	0.06	0.05, 0.07	0.04	0.03, 0.05	0.65	0.63, 0.68
Plain packaging, vape pods	0.36	0.33, 0.39	0.08	0.07, 0.09	0.07	0.05, 0.08	0.50	0.47, 0.53
Low nicotine strength, vape pods	0.42	0.39, 0.45	0.07	0.06, 0.09	0.07	0.05, 0.08	0.44	0.41, 0.47
Price increase, 40%								
Vape pods	0.36	0.33, 0.39	0.09	0.07, 0.11	0.07	0.06, 0.09	0.48	0.45, 0.51
Heated tobacco	0.40	0.37, 0.43	0.06	0.05, 0.07	0.07	0.05, 0.08	0.47	0.44, 0.50
Cigarettes	0.39	0.36, 0.42	0.07	0.05, 0.08	0.04	0.03, 0.05	0.51	0.48, 0.54
All	0.41	0.38, 0.43	0.07	0.05, 0.08	0.05	0.04, 0.06	0.48	0.45, 0.51
– Intention to purchase, users								
Status quo	0.55	0.51, 0.58	0.16	0.13, 0.18	0.19	0.17, 0.22	0.10	0.09, 0.12
On-product warnings								
Vape pods	0.52	0.49, 0.55	0.15	0.13, 0.17	0.19	0.17, 0.21	0.14	0.12, 0.16
Heated tobacco	0.54	0.51, 0.57	0.14	0.12, 0.16	0.20	0.17, 0.22	0.12	0.10, 0.14
Cigarettes	0.53	0.50, 0.57	0.16	0.14, 0.18	0.19	0.17, 0.21	0.12	0.10, 0.14
All	0.50	0.47, 0.53	0.14	0.12, 0.16	0.19	0.16, 0.21	0.18	0.16, 0.21
Plain packaging, vape pods	0.54	0.51, 0.58	0.15	0.13, 0.17	0.20	0.18, 0.23	0.11	0.09, 0.12
Low nicotine strength, vape pods	0.58	0.55, 0.62	0.16	0.13, 0.18	0.19	0.16, 0.21	0.07	0.06, 0.09
Price increase, 40%								
Vape pods	0.48	0.44, 0.51	0.20	0.16, 0.23	0.21	0.18, 0.24	0.11	0.09, 0.14
Heated tobacco	0.57	0.54, 0.61	0.14	0.12, 0.16	0.19	0.16, 0.21	0.10	0.08, 0.12
Cigarettes	0.55	0.51, 0.59	0.16	0.13, 0.19	0.16	0.14, 0.19	0.12	0.10, 0.14
All	0.53	0.49, 0.56	0.18	0.15, 0.20	0.17	0.15, 0.19	0.12	0.10, 0.14

Status quo, no on-product warnings, branding on vape pod packaging, high nicotine strength, and lowest prices; *vape pods*, 4 JUUL pods; *heated tobacco*, 50 IQOS Heets sticks; *cigarettes*, 25 du Maurier cigarettes; *Pr*, predicted probability; *CI*, confidence interval

among nonusers did not vary by province, household income, sex, age, or when lower quality respondents were excluded from the analysis.

Intention to purchase among users

At the status quo, the average e-cigarette user had a 0.55 (95% CI 0.51, 0.58) predicted probability of choosing vape pods, followed by cigarettes (0.19 [95% CI 0.17, 0.22]), heated tobacco sticks (0.16 [95% CI 0.13, 0.18]), and 'none' (0.10 [95% CI 0.09, 0.12]).

Introducing on-product warnings decreased the predicted probabilities of choosing each product, with a combined effect of increasing the predicted probability of choosing 'none' by eight percentage points to 0.18 (95% CI 0.16, 0.21). Own-price effects were in the expected direction for all three products. For example, increasing the price of vape pods by 40% reduced preferences for vape pods by seven percentage points (from 0.55 [95% CI 0.51, 0.58] to 0.48 [95% CI 0.44, 0.51]). Higher vape pod prices increased preferences for heated tobacco sticks and cigarettes by four and two percentage points, while higher prices for heated tobacco sticks increased preferences for vape pods but not for cigarettes. Higher cigarette prices, however, did not change preferences for vape pods or heated tobacco sticks. Plain packaging of vape pods did not change preferences, while lower nicotine strength was preferred by e-cigarette users.

Stated preferences among e-cigarette users generally did not vary by province, household income, sex, or if lower quality respondents were excluded from the analysis. Unlike e-cigarette users who did not use cigarettes, dual users did not indicate a preference for lower nicotine strength vape pods. Among dual users, higher own-prices decreased product preferences (i.e., higher vape pod prices decreased

Table 2 Results: risk perceptions, least risk to health (predicted probabilities)

Products	Vape pods		Heated tobacco		Cigarettes		Other	
Product attributes	Pr	95% CI	Pr	95% CI	Pr	95% CI	Pr	95% CI
– Nonusers								
Status quo	0.44	0.41, 0.47	0.12	0.10, 0.13	0.07	0.06, 0.09	0.37	0.34, 0.39
On-product warnings								
Vape pods	0.39	0.36, 0.42	0.12	0.10, 0.13	0.06	0.05, 0.07	0.43	0.40, 0.46
Heated tobacco	0.44	0.41, 0.46	0.10	0.09, 0.12	0.07	0.06, 0.08	0.39	0.36, 0.42
Cigarettes	0.41	0.38, 0.44	0.11	0.10, 0.13	0.07	0.06, 0.08	0.41	0.38, 0.44
All	0.35	0.32, 0.37	0.10	0.08, 0.11	0.06	0.05, 0.07	0.50	0.47, 0.53
Plain packaging, vape pods	0.45	0.42, 0.48	0.12	0.10, 0.14	0.08	0.06, 0.09	0.35	0.32, 0.37
Low nicotine strength, vape pods	0.50	0.47, 0.53	0.11	0.10, 0.13	0.08	0.07, 0.09	0.31	0.28, 0.33
Price increase, 40%								
Vape pods	0.43	0.40, 0.46	0.14	0.11, 0.16	0.09	0.07, 0.11	0.35	0.32, 0.37
Heated tobacco	0.43	0.40, 0.46	0.13	0.11, 0.14	0.09	0.07, 0.11	0.35	0.33, 0.38
Cigarettes	0.44	0.41, 0.48	0.12	0.10, 0.14	0.06	0.05, 0.07	0.38	0.35, 0.41
All	0.43	0.40, 0.46	0.13	0.11, 0.16	0.08	0.07, 0.10	0.36	0.33, 0.38
– Users								
Status quo	0.48	0.45, 0.51	0.19	0.17, 0.21	0.14	0.12, 0.16	0.19	0.16, 0.21
On-product warnings								
Vape pods	0.44	0.41, 0.47	0.19	0.17, 0.21	0.13	0.11, 0.15	0.24	0.21, 0.27
Heated tobacco	0.47	0.44, 0.50	0.18	0.16, 0.20	0.14	0.12, 0.16	0.21	0.18, 0.23
Cigarettes	0.47	0.43, 0.50	0.19	0.16, 0.21	0.14	0.12, 0.16	0.21	0.18, 0.24
All	0.41	0.38, 0.44	0.17	0.15, 0.19	0.12	0.11, 0.14	0.29	0.26, 0.32
Plain packaging, vape pods	0.50	0.47, 0.54	0.18	0.15, 0.20	0.15	0.13, 0.17	0.17	0.15, 0.19
Low nicotine strength, vape pods	0.54	0.50, 0.57	0.17	0.15, 0.20	0.14	0.12, 0.17	0.14	0.12, 0.16
Price increase, 40%								
Vape pods	0.50	0.46, 0.53	0.19	0.16, 0.22	0.13	0.11, 0.16	0.18	0.16, 0.21
Heated tobacco	0.49	0.46, 0.53	0.18	0.16, 0.21	0.16	0.14, 0.18	0.17	0.14, 0.19
Cigarettes	0.48	0.43, 0.52	0.19	0.15, 0.22	0.13	0.11, 0.15	0.21	0.18, 0.24
All	0.49	0.46, 0.53	0.18	0.15, 0.21	0.14	0.11, 0.16	0.19	0.17, 0.22

Status quo, no on-product warnings, branding on vape pod packaging, high nicotine strength, and lowest prices; *vape pods*, 4 JUUL pods; *heated tobacco*, 50 IQOS Heets sticks; *cigarettes*, 25 du Maurier cigarettes; *Pr*, predicted probability; *CI*, confidence interval

preferences for vape pods, while higher cigarette prices decreased preferences for cigarettes). Among dual users, higher prices for vape pods increased preferences for heated tobacco and cigarettes by three and four percentage points, respectively (from 0.20 [95% CI 0.17, 0.23] to 0.23 [95% CI 0.18, 0.28]) and from 0.33 [95% CI 0.29, 0.37] to 0.37 [95% CI 0.31, 0.42]). Higher heated tobacco prices increased preferences for vape pods but not cigarettes. Lastly, among dual users, higher cigarette prices increased preferences for heated tobacco by three percentage points (from 0.20 [95% CI 0.17, 0.23] to 0.23 [95% CI 0.18, 0.28]) but did not affect preferences for vape pods.

Among nondual users, cross-price effects between cigarette and vape pods and heated tobacco sticks were negligible, but not between vape pods and heated tobacco sticks. Higher vape pod prices increased preferences for heated tobacco by five percentage points (from 0.11 [95% CI 0.08, 0.14] to 0.16 [95% CI 0.11, 0.21]).

Users who reported having stopped using e-cigarettes for 1 day or longer in the last 12 months, relative to users who did not, stated similar preferences for 'none' regardless of price levels.

Risk perceptions

At the status quo, the average nonuser had a 0.44 (95% CI 0.41, 0.47) predicted probability of choosing vapes as the option that posed the least risk to health, followed by 'other' (0.37 [95% CI 0.34, 0.39]), heated tobacco (0.12 [95% CI 0.10, 0.13]), and cigarettes (0.07 [95% CI 0.06, 0.09]). For users, the equivalent predicted probabilities were 0.48 (95% CI 0.45, 0.51) for vapes, 0.19 (95% CI 0.16, 0.21) for 'other',

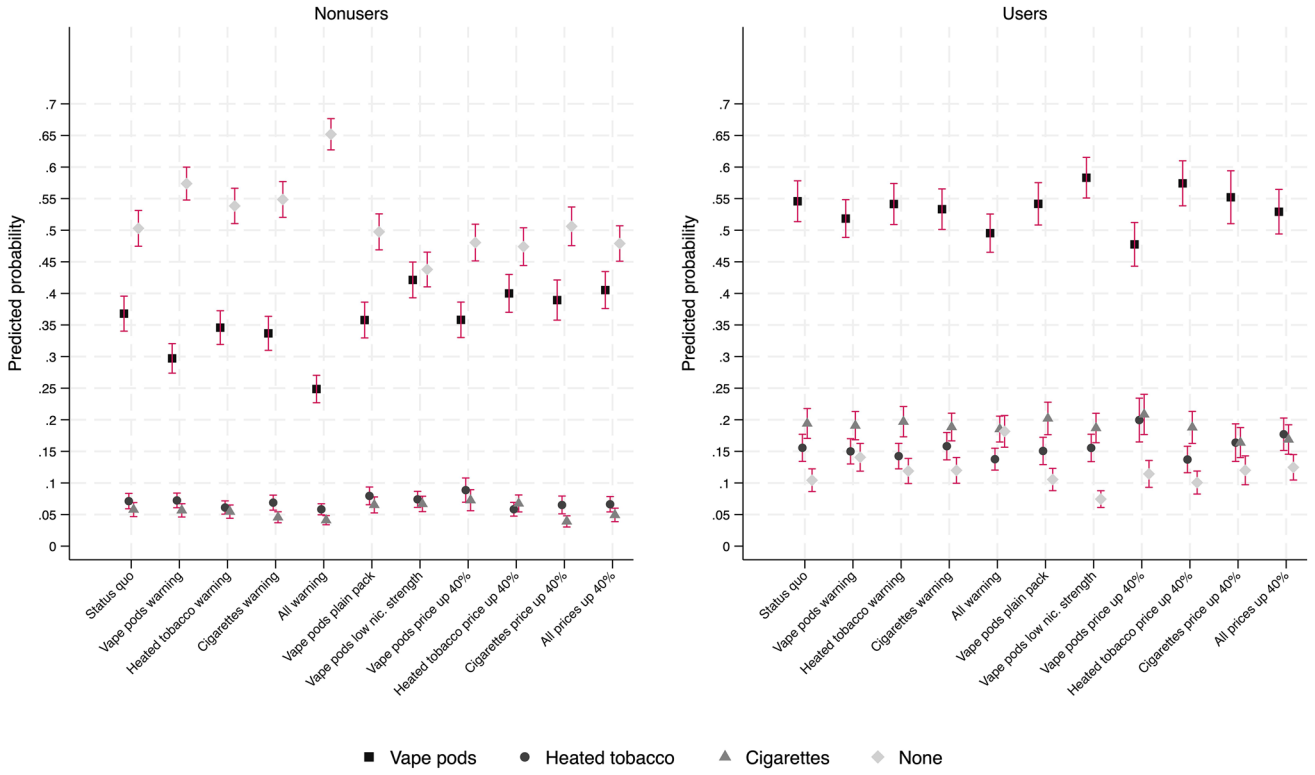


Fig. 2 Results: intentions to try (nonusers) and purchase (users), predicted probabilities

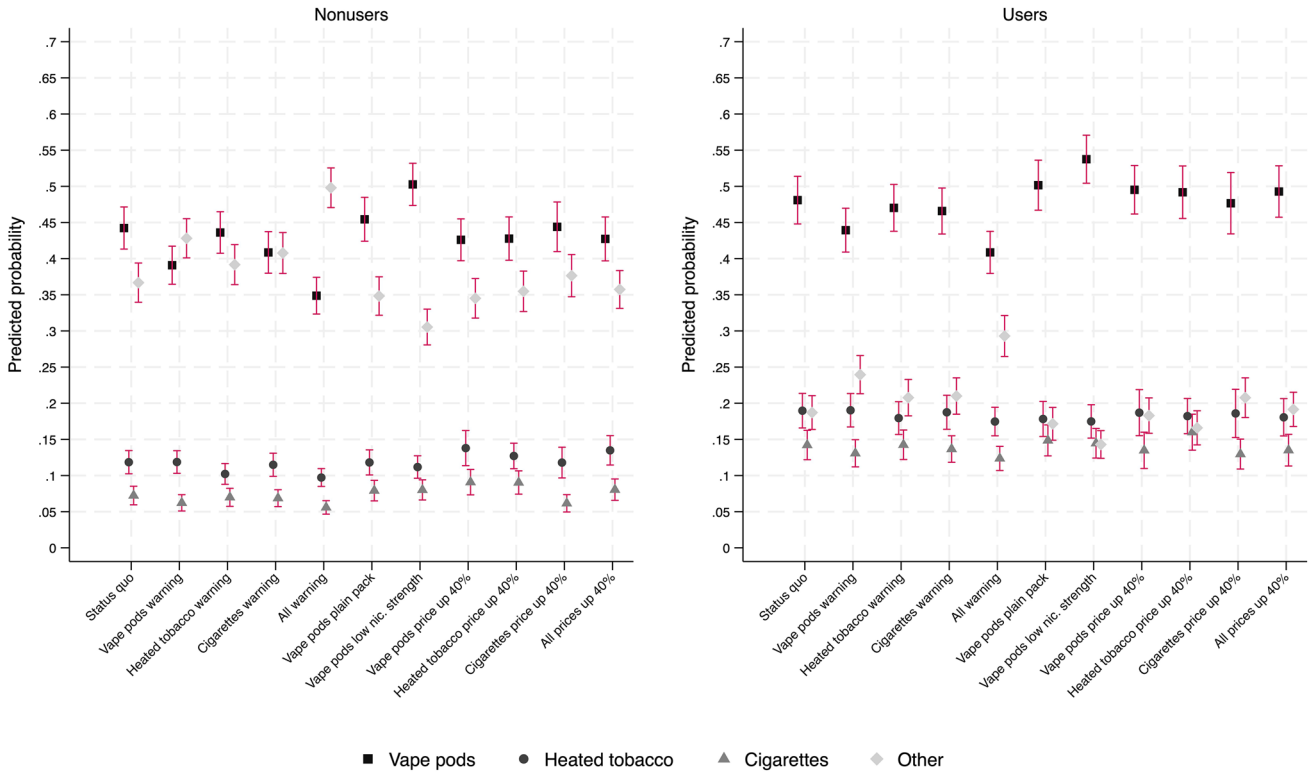


Fig. 3 Results: risk perceptions, least risk to health, predicted probabilities

0.19 (95% CI 0.17, 0.21) for heated tobacco, and 0.14 (95% CI 0.12, 0.16) for cigarettes.

On-product warnings had a combined effect of decreasing the probability of choosing vape pods by nine (from 0.44 to 0.35 [95% CI 0.32, 0.37]) and seven percentage points (from 0.48 to 0.41 [95% CI 0.38, 0.44]) and increasing the probability of selecting 'other' by 13 (from 0.37 to 0.50 [95% CI 0.47, 0.53] and ten percentage points for nonusers and users, respectively. Limits on nicotine strength had the opposite effect and increased the probabilities of choosing vapes while decreasing the probability of selecting 'other.' None of the attributes affected appreciably choices for cigarettes and heated tobacco. Subgroup analyses did not reveal any important differences.

Discussion

Contrary to statements made by manufacturers of nicotine products that e-cigarette regulations will inevitably lead to higher cigarette use, we did not find that enhanced regulations such as warnings on devices increased preferences for cigarettes among e-cigarette users; we found similar results among e-cigarette nonusers, most of which (93%) were also cigarette nonusers (Imperial Tobacco Canada, 2019; Rossel, 2024; UK Vaping Industry Association, 2024). We found that on-product warnings were particularly salient, and more importantly, that they appeared to work synergistically. For example, a warning on a vape device decreased the predicted probability of choosing vape pods by seven and three percentage points and increased the predicted probability of choosing 'none' by four and seven percentage points among users and nonusers, respectively. But a warning on all three products had substantially larger impacts; it decreased the predicted probability of choosing vape pods by seven and three percentage points and increased the predicted probability of choosing 'none' by eight and 15 percentage points. On-product warnings also affected risk perceptions; they decreased the probability of choosing vapes as the least risk to health option, without increasing the probability of choosing heated tobacco or cigarettes. Inasmuch as vapes are less harmful than cigarettes, on-product warnings increased misinformation about the relative harm of vaping vs cigarette use.

As expected by theory and evidence, e-cigarette users' preferences generally decreased for products with increased prices. Cross-price effects suggested that e-cigarettes and cigarettes were substitutes. However, effect sizes were fairly small and unlikely to be policy meaningful. Of note, higher cigarette prices did not change preferences for vapes or heated tobacco. Among dual users, higher vape pod prices increased preferences for cigarettes, but higher prices for all products decreased preferences for vape pods and cigarettes. With the exception of dual users, e-cigarette users who did not use cigarettes and nonusers showed a strong preference for vaping pods with lower nicotine content.

A small but growing literature has utilized choice experiments to jointly examine preferences for cigarettes and e-cigarettes. Studies generally found that higher e-cigarette prices reduced preferences for e-cigarettes while increasing preferences for cigarettes (Marti et al., 2019; Pesko et al., 2016; Yang et al., 2023). Price effects, however, varied in magnitude with relatively small cross-price effects. Two recent US studies found that, among adults (nonuser, cigarette and/or e-cigarette users) and smokers who had little interest in quitting cigarettes, higher cigarette prices were unlikely to increase preferences for e-cigarettes (Buckell et al., 2023; Zarate-Gonzalez et al., 2023). We found similar effects among e-cigarette users and dual users. As seen in one study of US e-cigarette users, we found that the product type (vapes, heated tobacco, cigarettes) was often more important than their attributes and that the heated tobacco product was the least preferred option (Yang et al., 2023).

Overall, our results can inform the design of e-cigarette and cigarette policies. First, and perhaps most importantly, our results provide support for introducing on-product warnings on all nicotine products simultaneously. Our findings that on-product warnings increased misinformation suggest that information campaigns should be considered in tandem with on-product warnings. Second, our results provide support for increasing prices on all products, and especially on cigarettes, as we found that higher cigarette prices did not affect preferences for vape pods, even among dual users. Third, our finding that lower nicotine strength was preferred by e-cigarette users suggests that the 2021 nicotine concentration limit of 20 mg/mL allowed in e-cigarettes may not have impacted e-cigarette use and that other policies ought to be introduced.

Limitations

First, given that only about 30% of respondents reported JUUL as their usual brand, a dislike for closed systems generally, and for the JUUL brand in particular, may have inflated the number of 'none' responses. Additionally, selecting 'none' cannot be interpreted as a preference to cease e-cigarette and cigarette use permanently. Second, in Australia and Canada, the cigarette warning is printed on the filter only. In the experiment, the warnings were placed on the combustible portion of the cigarette (Fig. 1). Third, respondents were part of an online panel. Consequently, our results may not generalize to individuals without regular online access. Fourth, among nonusers we examined intention to try, not intention to use. However, emerging research suggests that e-cigarette experimentation is associated with subsequent e-cigarette and cigarette use. Among

teens in Helsinki, Finland, e-cigarette experimentation with nicotine e-liquid increased the risk of daily use of nicotine e-cigarettes as well as cigarettes (Kinnunen et al., 2019). Among teens in Vermont, US, the probability of transitioning, within 6 months, from e-cigarette 'experimenting' to e-cigarette 'experienced' was 18% (Glasser et al., 2026). Moreover, there is a strong positive association between ever e-cigarette use (i.e., experimentation and use) and subsequent cigarette use (Chan et al., 2021; Khouja et al., 2021). Additionally, the intention to try question asked to nonusers is hypothetical in two dimensions. In addition to being asked about making hypothetical choices about products and their attributes/levels, subjects were asked to make choices with someone else in mind (i.e., for 'someone like you'). In our sample, 22% of nonuser respondents reported ever having used e-cigarettes (eTable 2), while the predicted probability at status quo is considerably higher, at 37% (95% CI 0.34, 0.40) (Table 1). The 2021/2022 cycle of the Canadian Tobacco & Nicotine Survey (CTNS) indicates that, among 15–24 years old, 22% had tried vaping (but not cigarettes) and that 17% had tried both vaping and cigarettes, for a total of 37% ever e-cigarette users (Health Canada, 2022). Although the similarity between our results and CTNS estimates is reassuring, the nonuser results should be interpreted with caution. Fifth, we explored heterogeneity in preferences between several subgroups. In doing so, we did not focus on statistical significance (Wasserstein & Lazar, 2016). Rather, we focused on differences in effect sizes that seemed large enough to be policy relevant. It is important to note that subgroup estimates are generally not precisely estimated and that differences between them are generally not statistically significant at the 0.05 level. Lastly, although the popularity of choice experiments to examine preferences in the context of health and health economics has increased substantially in recent years, stated preferences measured with choice experiments may differ from revealed preferences (Nouwens et al., 2025). However, a recent meta-analysis concluded that choice experiments were valuable tools for capturing health-related preferences and had reasonable external validity to predict health-related behaviours (Zhang et al., 2025).

Conclusion

Our findings provide additional support that on-product warnings (separate from warnings on packaging) may reduce experimentation and use of e-cigarettes, heated tobacco products, and cigarettes. Higher prices can also be expected to reduce use; higher cigarette prices in particular, as they did not increase preferences for alternative products. Furthermore, we found that removing branding from vape pod packaging had little effect on preferences, while lower nicotine strength increased preferences for vape pods.

Contributions to knowledge

What does this study add to existing knowledge?

- The rapidly changing policy e-cigarette and heated tobacco landscape makes it difficult to use standard empirical approaches such as quasi-experimental designs to examine the effect of policy changes on use intentions, purchase decisions, and risk perceptions.
- We conducted a discrete choice experiment that included choices over three products (vape pods, heated tobacco sticks, cigarettes) with four attributes: on-product health warnings, plain packaging for vape pods, nicotine concentration allowable in vape pods, and price.

What are the key implications for public health interventions, practice, or policy?

- Our findings provide additional support that on-product warnings (separate from warnings on packaging) may reduce uptake and use of e-cigarettes, heated tobacco products, and cigarettes.
- Higher prices can also be expected to reduce use; higher cigarette prices in particular, as they did not increase preferences for alternative products.
- Removing branding from vape pod packaging had little effect on preferences, while lower nicotine strength increased preferences for vape pods.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.17269/s41997-026-01270-2.

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Author contributions Guindon, Mentzakis, Buckley, and Montreuil conceptualized the study; Mentzakis, Guindon, and Atri analysed the data; Guindon, Mentzakis, Buckley, Atri, and Montreuil interpreted the data; Guindon drafted the manuscript; Mentzakis, Buckley, Atri, and Montreuil revised the manuscript critically for important intellectual content; all authors approved the final version, submitted for publication; Guindon, Mentzakis, Buckley, and Montreuil obtained funding.

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Data Availability Data and Stata code are available upon request.

Declarations

Ethics approval This study was approved by the Hamilton Integrated Research Ethics Board (HiREB); HiREB Project #: 12698.

Competing interests The authors declare no competing interests.

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