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To complement the termination of its agreement with PMI, GA's Board of Directors established a new policy to not accept or seek any tobacco or non-medicinal nicotine industry funding.

Risk Perceptions of E-Cigarettes and the Evaluation of EVALI Messaging

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*Corresponding Author. Data necessary to replicate the results of this article are available upon request from the corresponding author.

ABSTRACT

With the growth of sales of e-cigarettes and other alternative nicotine products, governments face the new challenge of crafting public health messages that provide information to consumers about these less risky but not risk-free products. Bayesian learning serves as the theoretical framework for our analysis of how smokers form their perceptions of the risks of e-cigarettes based on the risks of smoking. This paper consists of two parts. First, we conduct a cross-country descriptive analysis of government messaging and smokers' perceptions of e-cigarette risks. We study a diverse group of eight countries: Australia, China, Indonesia, Japan, Malaysia, Sweden, the U.K. and the U.S. We find that public health messages range widely across the countries. In online cross-country surveys of adult smokers, on average perceptions of e-cigarette risks are associated with their perceptions of the risk of smoking and with their countries' messaging. Notably, in all eight countries many smokers incorrectly believe that e-cigarettes are relatively more harmful than smoking and over-estimate the absolute risks of e-cigarettes. In the second part of our study, we report the results of online randomized experiments that compare the effects of different e-cigarette risk messaging about an outbreak of lung injuries (given the acronym EVALI). The U.K. public health message about the low risk of e-cigarettes relative to smoking reduced smokers' incorrect risk perceptions, while the U.S. public health message increased incorrect risk perceptions.

1. Introduction

Tobacco control policies across the world aim to reduce tobacco cigarette smoking to improve public health. Common policies include cigarette taxation, location-specific smoking bans, and marketing and advertising restrictions. A key component of global tobacco control policies are public health statements and messaging to provide information about the many health risks of smoking.

As the sales of alternative nicotine products like e-cigarettes account for a growing share of the tobacco and nicotine market, governments face a new challenge. They must provide information to consumers about these less risky but not risk-free products. In contrast to their consistent messaging about combustible cigarettes, governments' approaches to inform the public about e-cigarettes vary widely. Different countries' health and informational messaging are sometimes even in conflict with each other. The pronounced differences in messaging reflect the different views about e-cigarettes' health risks.

A long line of health economics research establishes that consumer risk perceptions drive many health behaviors, including smoking. Similar to combustible cigarette messaging, governments' e-cigarette messaging intends to improve consumer knowledge, which shapes consumers' risk perceptions, and, ultimately, informs consumers' decisions to switch from cigarettes to e-cigarettes or quit nicotine entirely. Consequently, the variation in governments' e-cigarette messaging should be expected to produce citizens with differing risk perceptions of e-cigarettes, and potentially different decisions about cigarette and e-cigarette use,

This paper consists of two parts. First, across eight countries we conduct a cross-country descriptive analysis of government messaging and smokers' perceptions of cigarette and e-cigarette risks. Second, we report the results of online randomized experiments that compare the

effects of different e-cigarette risk messaging on risk perceptions. In these experiments, we randomly assigned U.S. smokers either to a control group or to actual messages used by the U.S. or the U.K. and measure post-exposure risk perceptions. We also implement the same experiments for a sample of U.K. smokers.

Our descriptive analysis explores how countries' e-cigarettes messaging correlate with smokers' e-cigarette risk perceptions. We study a diverse group of eight countries: Australia, China, Indonesia, Japan, Malaysia, Sweden, the U.K. and the U.S. We start by collecting information on government websites that describes the health risks and/or harm reduction evidence about e-cigarettes. The data collected from government websites helps us to capture countries' views on e-cigarettes and the type of information they are disseminating to the public. Our first set of findings shows that statements on the health risks and possible benefits of e-cigarette usage vary dramatically across countries.

Next, we report the results of online surveys we conducted across the eight countries to gather data on smokers' perceptions of the relative and absolute risk of cigarettes and e-cigarettes. As with government messaging about e-cigarette risk, there are large differences in smokers' risk perceptions. The descriptive results of government messaging and our samples' risk perceptions suggest a correlation between government messaging and smokers' risk perceptions. In terms of both relative and absolute risks, the more negative a government's messaging about e-cigarettes, the riskier that country's smokers think e-cigarettes are.

In the second part of the paper, we report the results of online randomized experiments we conducted to examine whether government messaging about e-cigarette risks can causally influence consumer risk perceptions of e-cigarettes. Specifically, we examined U.K. and U.S. government messages about an outbreak of lung injuries in 2019 that the U.S. Center for Disease

Control (CDC) termed e-cigarette, or vaping product use-associated lung injuries (EVALI). Initially thought to be associated with nicotine e-cigarettes, EVALI was eventually linked to the use of illegal vaping products that contained THC (the psychoactive component of cannabis) and an additive that could be harmful to lungs (CDC, 2020b; Dave et al., 2020). In reaction to EVALI, the U.S. CDC used social media to disseminate explicitly negative messaging about the use of e-cigarettes. In contrast, the U.K. Health Security Agency messaging about e-cigarette during EVALI continued to reinforce the harm-reduction benefits of e-cigarettes compared to combustible cigarettes.

Our experiments exposed U.K. and U.S. smokers to either a control message or to an actual UK or US government message about EVALI. We compare subjects' risk perceptions based on the randomized exposure to each country's message. We find that exposure to the U.K. government's EVALI message, which emphasized the harm-reduction potential of e-cigarettes, increased the probability that respondents report e-cigarettes as less harmful than cigarettes, relative to seeing no message. The effect is present in both the U.S. and U.K. samples but is proportionally much larger in the U.S. sample. Exposure to the U.S. CDC message about EVALI, which emphasizes the harm of e-cigarettes, increased the probability that U.S. respondents report e-cigarettes as more harmful than cigarettes. Taken together, these results suggest that government messaging is a meaningful factor that affects how consumers perceive the relative risks of e-cigarettes.

In the next section we provide background on e-cigarettes, e-cigarette risk perceptions, and how the Bayesian learning framework helps explain e-cigarette risk perceptions. In section 3 we conduct a narrative review of cross-country health messaging and a descriptive analysis of our cross-country data on consumer risk perceptions. In section 4, we report the results of our

online randomized experiment of health messaging, analysis, and results. Finally, in section 5, we provide a discussion of our results and conclude.

2. Background

2.1 Tobacco Control and the Rise of E-Cigarettes

Globally, long-standing public health policies have sought to reduce tobacco use. Over the last two decades there has been a noteworthy reduction from 1.38 billion users in 2000 to 1.2 billion users in 2024 (WHO, 2025a). However, despite the global reduction in use, tobacco use continues to be a key public health issue, leading to an estimated 7 million deaths annually (WHO, 2025b). While tobacco use has fallen, in recent years the use of alternative nicotine products has increased. In many countries, the most popular alternative nicotine products are e-cigarettes. In some countries, most notably for our study Japan, heated tobacco products have substantial market shares. These products, also known as heat-not-burn products, are tobacco based but do not involve combustion. Oral nicotine pouches are a newer alternative nicotine product with a small market share.¹ Our study focuses mainly on e-cigarettes as the most commonly used alternative nicotine product.²

Modern e-cigarettes entered the market over 20 years ago, while the popular pod-based e-cigarettes entered the market in 2015 (Fadus et al., 2019). In the U.S. market, around 2022 the market share of large-capacity disposable e-cigarettes overtook the market share of pod-based e-cigarettes.³ The first e-cigarettes were created as a smoking cessation device that replicates the

¹ Most traditional smokeless tobacco oral products pose cancer risks. However, snus, a form of oral tobacco, is considered a lower-risk or harm reduction product. Snus has a low market share in most countries except Sweden, which is included in our sample.

² Where available, e-cigarettes are typically sold in retail establishments. In addition, the nicotine patch and gum are approved as therapeutic smoking cessation products.

³ CDC Foundation. (accessed August 19, 2026) National E-Cigarette Unit Share by Product Type. Available at: <https://tobaccomonitoring.org/national/>

experience of smoking without many of the associated risks (Baldassarri, 2020; Holt et al., 2023). Meta-analyses of randomized clinical trials conclude that e-cigarettes are a more effective method of smoking cessation than nicotine replacement therapies such as the nicotine pouch (Hartman-Boyce et al., 2022; Lindson et al., 2025). E-cigarettes are currently used both for smoking cessation and for non-cessation purposes. Many consumers are ‘dual users’ who smoke cigarettes and vape e-cigarettes. Some dual users go on to quit smoking within a year or two and may move on to quit vaping as well. Others remain dual users or vapers for longer periods of time.

Since their introduction, e-cigarettes have grown in popularity, especially among teen and young adult users. In 2024, the WHO estimated that 100 million people around the world use e-cigarettes and that at least 15 million users were between the ages of 13-15 (WHO, 2025a). The increased usage of e-cigarettes, especially among teens and young adults, has caused alarm among some public health officials leading to an increased emphasis on e-cigarettes as part of tobacco control policies.

There is general agreement that alternative nicotine products including e-cigarettes are less risky than smoking cigarettes, but there is disagreement about the degree of risk reduction. Nicotine by itself does not increase the risks of the major smoking-related causes of death. Instead, the health risks are linked to the carcinogens and other toxicants in tobacco smoke created by combustion. E-cigarettes, heated tobacco products, and nicotine pouches do not involve combustion and so expose users to much lower levels of the risky components of smoke. In assessing independent research results regarding the relative risk of e-cigarettes, the Royal College of Medicine concludes that, while the possibility of harm from long-term e-cigarette use cannot be dismissed due to inhalation of ingredients other than nicotine, the health risk is likely

to be very small, and substantially smaller than that arising from smoking combustible cigarettes (Royal College of Physicians, 2016; Hartman-Boyce et al., 2023). Similarly, the U.S. FDA currently emphasizes that tobacco products exist on a continuum of risk, from the lower-risk non-combusted products such as e-cigarettes to very risky combustible cigarettes.⁴ Based on a broad review of evidence, Public Health England suggests a benchmark that vaping e-cigarettes is 5% as risky as smoking (McNeil et al. 2018). In a survey of public health experts, the median of the 137 responses was that the impact of vaping on life expectancy is 25% as large as the impact of smoking (Allcott and Rafkin, 2022). An FDA regulatory impact analysis uses estimate that e-cigarettes are 12% as risky as smoking (FDA 2023, p. 18). Below, we use 15% as a benchmark consensus estimate of the e-cigarette risks relative to smoking, although we recognize disagreements in both directions around this benchmark.⁵

2.2 E-cigarette Risk Perceptions

Despite the research findings that e-cigarettes are less risky than cigarettes, consumer subjective risk perceptions are not well aligned with the science. A significant literature documents that a substantial percentage of consumers believe that e-cigarettes are as harmful or even more harmful than cigarettes. Even as e-cigarette use increased, the percentage of

⁴ FDA (accessed August 19, 2026). <https://www.fda.gov/tobacco-products/health-effects-tobacco-use/relative-risks-tobacco-products>. Below, in our narrative review of countries' health messaging we review health messages about e-cigarettes from the U.S. CDC. We examine the CDC messages because the CDC is a major public-facing U.S. health authority. The FDA's current webpage on the continuum of risk dates back to around April 2024, the earliest date it was saved by the Wayback Machine.

⁵ The 15% benchmark is the simple average of the 5% Public Health England (2018) estimate and the 25% median estimate from the experts surveyed by Allcott and Rafkin (2022). Consistent with the 15% benchmark, an FDA analysis assumes that the excess mortality risk of use of all non-combusted tobacco products, a category which mainly consists of e-cigarettes, is 12% the excess mortality risk of smoking (FDA 2023, p. 18). In sensitivity analysis, the FDA varies the assumed excess mortality risk of non-combusted tobacco use to be from 7% to 20% the excess risk of smoking (FDA 2023, p. 18). A technical FDA guidance document on estimating excess lifetime cancer risks (ELCR) of tobacco products places the ELCR of then-currently authorized e-cigarettes at 118 excess cancer cases per 100,000 users; this is slightly over 1% of the ELCR of smoking, which is placed at 10,000 per 100,000 smokers (Almamun et al. 2024, pp. 11-12).

consumers with the belief that they are as harmful or more harmful than cigarettes rose over time. Over a decade ago, Ambrose et al. (2014) found that only one in three youth believed that e-cigarettes were less harmful than cigarettes. Using the Tobacco Products and Risk Perceptions surveys, Majeed et al. (2017) found that the percent of respondents that perceived e-cigarettes to be at least as harmful as cigarettes rose from 12.8% in 2012 to 39.8% by 2015. Huang et al. (2019) documented that the proportion of U.S. adults who perceived e-cigarettes to be as harmful traditional cigarettes increased substantially from 11.5% in 2012 to 36% in 2017 in one dataset, and from 46% to 56% in another dataset.

In 2019, EVALI increased concerns about e-cigarette risks among public health officials and the public. As summarized in Dave et al. (2020), the EVALI outbreak began in Spring 2019. EVALI cases peaked in mid-September with cases slowly but steadily declining in the coming months. By 2020 a total of 2,807 hospitalizations or deaths related to EVALI were reported nationwide in the U.S. The CDC used the EVALI acronym (E-cigarette or vaping associated lung injuries) in its interim guidance issued to health care providers on October 11th (Siegel et al., 2019). As the acronym suggests, EVALI was first thought to be related to nicotine-containing e-cigarette use. In its initial messaging to the public the CDC cautioned users to refrain from e-cigarette products and vaping (Dave et al., 2020). By the end of the year, it was concluded that black market e-cigarettes containing THC and an adulterant likely caused the injuries (CDC, 2020b; Zulfiqar et al., 2023). The CDC subsequently changed its messaging to focus on THC vaping products.

Despite the evidence that EVALI was caused by THC vapes, the impact of EVALI on risk perceptions of all e-cigarettes was dramatic. As noted earlier, prior to EVALI, Huang et al. (2019) documented that the proportion of US adults who perceived e-cigarettes to be as harmful

as or more harmful than traditional cigarettes had already increased from 2012 to 2017. EVALI pushed these rates even higher. Dave et al. (2020), Moustafa et al. (2021), Kreslake et al. (2022), Wackowski et al. (2023), and Jin et al. (2024) all find increased risk perceptions of e-cigarettes after EVALI.

Outside the US, cases attributed to and reactions to EVALI were more muted. In 2019, multiple news outlets noted EVALI seemed to be only a US phenomenon (Hunt, 2019; Kelland, 2019). A retrospective analysis that attempted to establish if reported lung injuries in other countries met the CDC's 'probably case' criteria, found limited number of cases meeting the clinical threshold for EVALI (Sund et al., 2023).

2.3 Bayesian Learning Model and the Formation of E-Cigarette Risk Perceptions

Bayesian learning provides a useful framework for understanding how individuals form and revise their subjective risk perceptions of vaping. Viscusi's (2016) application of Bayesian learning to e-cigarette risks serves as the theoretical framework for our analysis. While vaping and smoking can carry multiple health risks, the Viscusi model summarizes these risks in a single measure capturing the probability of death. In the model, one term represents the perceived mortality risk of vaping, and an analogous term represents the mortality risk of smoking. Because e-cigarettes are the newer product, the model assumes that individuals form their beliefs regarding e-cigarette risks in relation to cigarettes. Cigarettes serve as a reference point (Bayesian prior) for individuals because their risk profile is less uncertain and better understood. Individuals' initial risk assessment of e-cigarettes is later updated as new information becomes available.

Viscusi (2023) studies the role the Public Health England's harm reducing messaging played in adults' risk perceptions of e-cigarettes. The U.K.'s tobacco control efforts have

consistently promoted e-cigarettes as harm-reduction products that are significantly safer than cigarettes. Viscusi finds that despite communicating “e-cigarettes provide at least a 95% risk reduction compared to conventional cigarettes,” most adults still view e-cigarettes as only 30-40% safer. He did, however, find that despite continuing to underestimate the risk reduction of e-cigarettes, adults familiar with the health messaging viewed e-cigarettes as less risky than those unaware of the messaging.

The Viscusi learning model is also related to behavioral economics models of risk perceptions in which consumers apply anchoring-and-adjustment mechanisms. In this framework, when estimating the risk of a choice (e.g. the life-years lost from vaping), individuals begin with an initial anchor that is perceived as less uncertain (e.g., life-years lost from smoking) and then adjust away from that anchor in response to new information. However, the adjustment process may be influenced by behavioral heuristics, leading consumers to rely too heavily on an initial anchor and make insufficient adjustments (Tversky and Kahneman, 1974).

We use the predictions from the Bayesian and anchoring-and-adjustment behavioral models of risk perceptions to guide our analyses. For our cross-country analysis of e-cigarette risk perceptions, the models suggest that cross-country differences in the perceived risks of cigarettes will lead to similar differences in e-cigarette risk perceptions. The anchoring-and-adjustments behavioral model further suggests that the initial correlation between cigarette and e-cigarette risk perceptions may continue to persist over time. The long-run correlation is expected to reflect different governments' approaches to health messaging which may cause consumers to update their risk perceptions to different degrees and possibly even in different directions. However, like in Viscusi (2023), even sustained informational campaigns struggle to overcome individuals' anchoring of e-cigarette risk perceptions to cigarettes.

The Bayesian and anchoring-and-adjustment behavioral models of risk perceptions also guide our analysis of the results of our health messaging experiment. The experimental results provide estimates of the causal impacts of different health messages on e-cigarette risk perceptions. That is, the experiment allows us to estimate the degree and direction of updating caused by the new information provided in the U.K. and U.S. messages about EVALI. EVALI provides an especially salient context to study risk perceptions because the information provided in the government messaging focused specifically on e-cigarette risks.

3. Government Messaging about E-Cigarettes and Consumer Risk Perceptions

This section reports our descriptive cross-country analysis of government messaging about e-cigarettes and smokers' risk perceptions. We first provide a narrative review of differences in government messaging about e-cigarettes, supplemented with a quantitative sentiment analysis of the messaging. We then discuss our cross-country survey data on smokers' risk perceptions. Finally, we describe the relationship between countries' public health messaging and smokers' risk perceptions.

3.1 Government Messaging about E-Cigarettes

Our analysis begins by documenting countries' public health messaging related to e-cigarettes. Table 1 reports information about e-cigarettes that is disseminated on government websites for Australia, China, Indonesia, Japan, Malaysia, Sweden, the U.K., and the U.S. There are dramatic differences in both the extent to which governments focus on e-cigarettes and the extent to which they focus on the possible positive or negative health implications of e-cigarettes.

Comparing Australia, the U.K., and the U.S. is particularly enlightening. The Australian government website focuses almost entirely on the risks of using e-cigarettes and dismisses the evidence that e-cigarettes can be an effective smoking cessation product. The messaging

highlights the toxins in e-cigarettes without mentioning, like some other countries do, that e-cigarettes contain far fewer amounts of toxins compared to combustible cigarettes. The U.K. government messaging takes the completely opposite approach. Their messaging features relative harm statements noting that e-cigarettes are safer than cigarettes and urges adult smokers to switch to them. The U.S. CDC's messaging is closer to Australia's than to the U.K.'s approach. Most of the CDC's e-cigarette messaging focuses on the harms of e-cigarettes.

For Japan and China, we found virtually no government statements about the risks of e-cigarettes (China) or heated tobacco products (Japan). We modified the survey administered to the Japan sample to ask about heated tobacco products given their high market share in Japan. Heated tobacco products were introduced in Japan in 2014 and by the early 2020s their market share was reaching the market share of cigarettes (Kenkel et al., 2025). Given their market share, the lack of government messaging is somewhat surprising; apparently the growth in heated tobacco sales has been driven by private sector efforts.

Sweden takes a different approach and just provides data on usage of different types of products with little focus on the absolute or relative risk of alternative nicotine products. Sweden is also a special case given its long experience with snus, a reduced-risk oral tobacco product.

To corroborate our narrative review, we utilized the VADER algorithm in Python, typically used for performing sentiment analysis, to evaluate the level of negative/positive sentiment about e-cigarettes in the messages. In Table 1 we report the sentiment scores range from -1 (most negative) to +1 (most positive)⁶. The results are consistent with the narrative review above. Australia and the U.S have sentiment scores of -0.97 and -0.95 respectively. In contrast,

⁶ The image in Indonesia's warning was not included in the VADER analysis. We used the text translated from the image.

Sweden and the UK have positive scores of 0.49 and 0.82 respectively. The sentiment scores in the low- and middle-income countries in our sample range from negative scores in China (-0.29) and Indonesia (-0.48) to a positive score in Malaysia (0.27). These sentiment analysis scores can be sensitive to the choice of algorithm and of course the sections of the website verbiage that we included in Table 1.

3.2 Surveys and Data Collection

The cross-country risk perceptions data come from questions included as part of a set of online discrete choice experiments with adult smokers. We utilized the survey firm SSRS to conduct our surveys in the eight countries listed in Table 1. The surveys consisted of three sections. The risk perception questions were in the third section and were asked after respondents had completed a background survey and the choice experiment.⁷ The target sample sizes for each country were 600 observations except for the 2021 U.S sample where the goal was to collect 1200 observations. For all countries except Malaysia, the surveys were first conducted in 2021; the Malaysia survey was conducted in 2023. A second round of surveys was conducted in 2022 in the U.S. and in 2023 in Australia and China. To maximize comparability across countries the survey consisted of identical questions, although language translation introduces some possible variability. The one key difference in questions was that the Japan survey asked about risk perceptions for heated tobacco products (HTPs) rather than e-cigarettes, because HTPs products are much more popular in Japan. Research suggests that e-cigarettes and HTPs pose roughly the same absolute risks and that relative to combustible cigarettes, both products are much less harmful.

⁷ The results of the discrete choice experiments are reported in separate manuscripts (Kenkel et al., 2024, 2025, 2026; Wang et al. 2026).

The surveys included two messages of risk perceptions that we will be leveraging for our descriptive analysis. To measure the risk perceptions of e-cigarettes *relative* to cigarettes each respondent was asked:

Compared to smoking cigarettes would you say that e-cigarettes (we use the term heated tobacco for Japan) are: much less harmful, less harmful, about the same, more harmful, less harmful or I don't know.

Based on the answers to these questions we combined the less harmful and much less harmful responses into one category and the more harmful and much more harmful response into another category. To measure *absolute* risk perceptions of cigarettes and e-cigarettes we use answers to these two questions.

As you may know, an average 21-year-old would be expected to live to the age of about 80. What do you think the life expectancy is for the average smoker?

As you may know, an average 21-year-old would be expected to live to the age of about 80. What do you think the life expectancy is for the average vaper of nicotine-based e-cigarettes?

In the questions, the expected life span of an average 21-year old varied based on the respondent's gender and the specific life-span data for each country. From the answers to these questions, we calculate for each respondent their expected life years lost from smoking cigarettes and life years lost from vaping e-cigarettes.

3.3 Results from Cross Country Risk Perceptions

Figure 1 shows the cross-country comparisons of the percentage of respondents who report that e-cigarettes are less harmful (i.e., if they reported less or much less harmful) and more harmful (if they reported more or much more harmful) than cigarettes. The figure shows the results across the eight countries with two sets of results for the surveys in Australia, China, and the U.S. For Japan the comparison is between heated tobacco products (HTPs) and cigarettes.

The results reveal large differences across countries. Japan, Sweden, and the UK had the most accurate relative risk perceptions, with Japan leading the way. Sixty-two percent of Japan respondents report that HTPs are less harmful than cigarettes with only four percent perceiving HTPs to be more harmful.⁸ The results for Sweden and the UK are very similar to each other. In Sweden, 52% of respondents report that e-cigarettes are less harmful than cigarettes with only 6% reporting that they are more harmful. In the UK, 51% of respondents perceive e-cigarettes to be less harmful with 9% believing them to be more harmful. Despite Japan, Sweden and the UK having more accurate relative risk perceptions than the other countries, these numbers are still showing high degree of inaccurate beliefs about the risks of e-cigarettes. Only slightly more than half correctly believe that e-cigarettes pose less risk than cigarettes.

Only 22% of the respondents from the 2023 Australian survey reported that e-cigarettes are less harmful than cigarettes and 18% indicated that e-cigarettes were *more* harmful than cigarettes. It is also interesting to note that there was a sharp decrease in the percentage thinking e-cigarettes are less or much less harmful in Australia between the 2022 and 2023 cross-sections, going from 32% in 2022 to the 22% reported above for 2023. The U.S. is not far behind Australia, with only 25% in the 2021 survey and 26% in the 2022 cross-sections believing that e-cigarettes are less harmful. The more harmful results are also striking with 17% of the U.S. sample believing that e-cigarettes are more harmful than cigarettes. China, Indonesia and Malaysia are in between these extremes on the less harmful measure, with percentages believing e-cigarettes to be less harmful ranging from 42% to 48%. The percentages believing e-cigarettes to be more harmful for these countries are very similar to the high numbers of the U.S.

⁸ The Japan results might reflect the difference between heated tobacco products and e-cigarettes. Even though research suggests they present similar risks, it might be more obvious to smokers that heating instead of combusting tobacco poses lower risks.

Figure 2 shows the results for our measures of the absolute risk perceptions of cigarettes and e-cigarettes (HTPs for Japan). The cross-country comparisons of absolute risk perceptions reveal several interesting patterns. First, the perceived life years lost from smoking and vaping tend to be very correlated within a country. Countries where consumers perceived only a few life years lost from smoking cigarettes also perceived lower levels of life years lost from vaping.

For example, respondents from countries in Asia (China, Indonesia, Japan and Malaysia) perceived fewer life years lost from smoking than other countries. Chinese respondents reported 7 life years lost in 2021 and 6 life years lost in 2023. The Indonesian data indicates that, on average, consumers perceived 5 life years lost from cigarette smoking. For Japan and Malaysia, the average was 7 and 5 life years lost respectively. The vertical lines in Figure 2 show consensus benchmark estimates of life years lost from smoking and vaping. Among public health researchers, a commonly cited estimate of the life expectancy loss due to smoking is 10 years (Jha et al. 2013). Above, we reviewed evidence that supported the benchmark estimate that vaping is 15% as risky as smoking, which implies the benchmark that the life expectancy loss due to vaping is 1.5 years. Respondents in China, Indonesia, Japan and Malaysia all underestimate the risk of cigarettes relative to the consensus (10 life years lost) and these countries also have the lowest estimates of the life years lost from e-cigarettes or HTPs. Meanwhile, respondents in the US, UK and Sweden report the highest level of life years lost due to smoking and hover around the consensus estimate of 10 years. These respondents also report the highest level of life years lost from e-cigarettes.

A strong correlation between life years lost from smoking and life years lost from e-cigarettes is visually apparent in Figure 2; the lengths of the bars are clearly related to each other. These results are consistent with the predictions from the Bayesian learning model discussed

above. Because cigarettes predate e-cigarettes, a reasonable interpretation of the data in Figure 2 is that the risk perceptions of cigarettes may be the starting point for smokers to form their perceptions of the risk perceptions of e-cigarettes, broadly in line with both the Bayesian learning framework and a behavioral anchoring-and-adjustment model.

The second key finding in Figure 2 is that on average respondents across all countries overestimate the life-years lost from vaping, well exceeding the 1.5-year consensus. Although 1.5-years is somewhat arbitrary, the conclusion that on average the life-years lost from vaping is an over-estimate holds for other benchmarks, such as the 0.5-year estimate from Public Health England of the 2.5-year median of experts' surveyed by Allcott and Rafkin (2022). Even in countries that perceive life years lost from smoking cigarettes below the consensus estimate, the estimate of the life years lost from vaping is still large and well exceeds 1.5 years. Our results mirror the findings from a prior study of the UK, where even respondents who are familiar with the Public Health England's messaging over-estimate the relative risk of e-cigarettes (Viscusi 2023).

Finally, comparisons of the government messaging shown in Table 1 with the findings shown in Figures 1 and 2 suggest a link between messaging and risk perceptions. From Table 1, it is quite clear that Australia and the U.S. have the most explicit and longest statements focused on the harm of e-cigarettes and devote significant amount of government public health messaging to discussing these harms. Across the countries analyzed in Figures 1 and 2, Australia and the U.S. also have the lowest percentage of adults reporting that e-cigarettes are less harmful than cigarettes. Australia and the US are tied for the highest percentage of adults reporting that e-cigarettes are more harmful than cigarettes (also tied with China and Indonesia.) Finally, Australia and U.S. smokers on average report the largest estimate of the life years lost from

vaping. Interestingly, smokers in Australia and the U.S. also have reasonably accurate perceptions of the life years lost from smoking. Their average perceived life years lost due to smoking are close to the consensus estimate of 10 years.

Given the apparent strength of cigarettes risk perception as an anchor for e-cigarettes risk perceptions, it is useful to re-visit U.K. government messaging. As noted in Viscusi (2023) and shown in Table 1, the UK makes explicit positive statements of e-cigarettes compared with cigarettes noting that they are much less harmful. The messaging focused on distinguishing e-cigarettes from cigarettes. While respondents in the UK do overestimate the absolute risk of e-cigarettes, across all the countries examined in Figure 2, the UK respondents have the largest difference in perceived life years lost between cigarettes and e-cigarettes. UK respondents report on average 12 years lost from smoking cigarettes and 9 years lost from vaping. However, comparing Table 1 and Figures 1 and 2 is only suggestive evidence of a connection between government messaging and risk perceptions. A different research design is necessary to examine whether government messaging can have a causal impact on risk perceptions.

4. Experiment Comparing U.K. and U.S. Smokers' Reactions to E-cigarette Messaging

The experimental portion of this paper is motivated by our descriptive results suggesting a connection between government messaging and smokers' risk perceptions. After establishing a descriptive connection between the two, we seek to examine whether this relationship is causal. In order to estimate the causal impact of government messaging on risk perceptions, the online experiment randomly exposed U.K. and U.S. smokers either to a control message or to different government messaging about the risks of e-cigarettes. Studying the influence of messaging on risk perceptions in the context of the US and the UK is especially useful because smokers in the two countries have potentially different strengths of anchoring e-cigarette risk perceptions to

cigarette risk perceptions and may have undergone different adjustments to their risk perceptions.

4.1 Data

We used online opt-in Pollfish surveys, in both the U.K. and the U.S., to implement our experimental design. Pollfish is a cost-effective and rapid method to conduct online surveys. Pollfish reaches consumers on their mobile devices while they are using applications; respondents opt-in to surveys and provide self-reported demographics. Eckman et al. (2018) provide more discussion of Pollfish and the advantages and disadvantages of conducting surveys through applications installed on mobile devices. Academic researchers in marketing and social sciences increasingly rely on online opt-in surveys as a valuable source of data on a range of topics (Hulland and Miller 2018). Several studies have been conducted of the accuracy and biases of online opt-in survey data (Mercer et al., 2018; Sostek, 2019).

The surveys were conducted November 1-2, 2022. A sample of 4,000 U.S. adult smokers were randomized into either a control group or one of three messages about vaping. The three messages were based on government agencies' Twitter posts from 2019. We used a post from the U.S. Centers for Disease Control about EVALI; a post about EVALI from the U.K. Health Security Agency; and a post about the teen vaping epidemic from the U.S. FDA. We include this latter message because around the time of the EVALI outbreak, the FDA also began efforts to address the rising rates of youth vaping. Such messaging could also impact adult risk perceptions of the risk of e-cigarettes.

The Twitter posts are not hypothetical. The U.S. and U.K. government agencies posted them during the EVALI events of 2019. The identical survey design was implemented on the

same dates for a sample of 4,000 U.K. adult smokers. Appendix A includes the survey instrument we implemented; the study was pre-registered at the AEA RCT Registry.⁹

Figures 3, 4, and 5 show the posts displayed to respondents depending on their treatment assignment. If assigned to the US CDC message treatment group, respondents were shown Figure 3, in which the CDC suggests individuals refrain from vaping, especially THC products. If assigned to the UK message treatment group, respondents were shown Figure 4, where the UK Health Security Agency notes that their advice about e-cigarettes does not change in response to EVALI and emphasizes that e-cigarettes are less harmful than cigarettes. If assigned to the FDA Youth message, treatment-group subjects were shown Figure 5, in which the FDA summarizes their intended actions to address the youth vaping epidemic and emphasizes enforcement efforts that will be taken against flavored e-cigarettes. Finally, if assigned to the control group there was no Twitter message shown.

The survey questionnaire also included identical questions on relative risk perceptions and absolute risk perceptions as the SSRS cross-country survey questions discussed above in section 3. These questions allow us to estimate the causal impact of the experimentally assigned messages on the relative and absolute e-cigarette risk perceptions.

4.2 Descriptive Statistics and Experimental Balance

Tables 2 and Table 3 present the descriptive statistics for the U.K. and U.S. samples, respectively. The descriptive statistics include the full U.K. and U.S. samples and sub-samples broken down by control and experimental treatment groups. The number of observations in each sub-sample (1,000) are equal across each of the treatments. The survey was designed so each of

⁹ See <https://www.socialscisceregistry.org/trials/10303>

the 8 identical Pollfish surveys (with the message treatment and U.K. or U.S. sample being the only difference) ended when each survey reached 1,000 usable observations.

Like the descriptive results in Figures 2, we see large differences in the relative risk perceptions of e-cigarettes across the two countries. Fifty four percent of the respondents in the U.K. (Table 2) report that e-cigarettes are less harmful than cigarettes, compared with only 29% of the U.S. sample (Table 3). This matches very closely with the results in Figure 2 where 51% of that UK sample reported less harmful, compared with 26% in the U.S. sample.

By experimental design, the demographic variables should be orthogonal to the treatment assignments. As shown in Tables 2 and 3, most variables have similar means across the different treatment samples. There are, however, a few exceptions. For example, in the US sample, the control group has somewhat of a different age distribution than the other treatment groups, with fewer young adults in the control group. The distribution of race also appears to differ across treatment categories. Table 4 reports the results of linear probability models where we formally test experimental balance (joint orthogonality) by examining whether demographic characteristics are statistically related to treatment group assignments. Race and age are statistically related to the treatment assignments, so we include these variables in our regression analyses.

4.3 Results

Tables 5 and 5a (U.S. Sample) and Tables 6 and 6a (U.K. Sample) present the estimated effects of the experimentally assigned messages on perceptions of the relative risks of e-cigarettes. Separate linear probability models are run for much less harmful (first column), less harmful (second column), equally harmful (third column), more harmful (fourth column), much more harmful (fifth column), or don't know (sixth column). Because the responses are naturally

ordered, an alternative specification would be to combine them into a single variable and estimate an ordered probit or logit model. However, the specifications in Tables 5 and 6 are more flexible and allows the experimental treatment effects to vary at different margins; for example, messages might have smaller effects on the probabilities of the more extreme responses much less or much more. The key explanatory variables are the three indicators for message treatment group as compared to the control group (omitted category). As explained above, the models also control for age and race to correct for lack of experimental balance, In addition, to explore the role education might play in risk perception formation, the Tables 5 and 6 models include an indicator for university education or more. Tables 5a and 6a present models where the education level of the respondent is interacted with the treatment variables.

For the U.S. sample, compared to the control group, exposure to the U.K. EVALI message increased the probability of perceiving e-cigarettes as less harmful than cigarettes by 7.4 percentage points, which is an increase of one-third the sample mean (Table 5). Exposure to the CDC EVALI message had a small (0.014) and statistically insignificant effect. In contrast, exposure to the CDC EVALI message increased the probability of perceiving e-cigarettes as more harmful by 4.8 percentage points, which is an increase of almost 40 percent of the sample mean (Table 5). Interestingly, the U.K. and CDC messages mainly shifted perceptions from just as harmful into the less or more harmful categories. The fractions of subjects with more extreme perceptions that e-cigarettes were much less or much more harmful were relatively unresponsive to the different messaging. Interpreted in light of the Bayesian learning and anchoring-and-adjustment models, the risk perceptions of subjects who report that e-cigarettes as just as harmful as smoking are still close to their initial anchoring on the risk of smoking; subjects with more extreme perceptions have already updated their beliefs away from the initial anchors. The pattern

of estimated treatment effects suggests that once people have updated their beliefs, the new information in the messages may be less persuasive.

For the U.K. sample, compared to the control group, exposure to the U.K. EVALI message increased the probability of perceiving e-cigarettes as less harmful by 4.7 percentage points, an increase of 11 percent of the sample mean (Table 6). This increase is smaller than the estimated increase in the U.S. sample in absolute terms and relative to the sample mean. Similar to the U.S. sample, the U.K. message mainly shifted perceptions from just as harmful into less harmful and did not statistically significantly change the fractions with more extreme perceptions.¹⁰

In both the U.S. and U.K. samples, we find that a university education is associated with statistically significantly higher probabilities of perceiving e-cigarettes as less harmful than smoking (Tables 5 and 6). The results in Tables 5a and 6a, where the educational variables are interacted with the message treatment variables, reveal no significant interaction effects. These patterns suggest that while university graduates have an informational advantage and are more likely to correctly perceive e-cigarettes as less harmful, there is no strong evidence that in

¹⁰ Our preregistered data plan indicates that we would also examine secondary outcomes though this is not the primary focus of the paper. The secondary outcomes focused on behavioral intentions including “considering quitting e-cigarettes in the next 6 months, considering quitting e-cigarettes in the next 6 months and switching to cigarettes, considering quitting cigarettes in the next 6 months, considering quitting smoking in the next 6 months and considering quitting smoking in the next 6 months and switching to e-cigarettes. The descriptive statistics for these variables by message treatment are provided in Tables 2 and 3. We ran separate regressions for each of the four behavioral intention variables. For the UK sample those exposed to the FDA youth message reported a lower probability of considering quitting smoking by switching to e-cigarettes. For the US sample those exposed to the CDC message had lower probabilities of considering quitting smoking by switching to e-cigarettes while those exposed to the FDA youth message were more likely to consider quitting e-cigarettes but less likely to consider quitting e-cigarettes by switching to smoking.

response to the messages, they update their perceptions differently than those with less than a university education.

Finally, Tables 5 and 6 show important age differences in perceptions about the relative harm of e-cigarettes, with different patterns among the U.S. and U.K. subjects. For example, compared to the youngest age group under the age of 25 (the omitted category), U.S. subjects aged 45 to 54 were 6.7 percentage points less likely to perceive e-cigarettes as less harmful than smoking; U.K. subjects in that age group were 7.4 percentage points more likely to perceive e-cigarettes as less harmful. We speculate that this difference might reflect the success of U.K. messaging to inform middle-aged smokers that e-cigarettes are a less harmful alternative that may help them quit.

5. Discussion

Risk perceptions of e-cigarettes vary dramatically across countries. Even within countries where a higher percentage of smokers correctly believe e-cigarettes are less harmful than cigarettes, the percentages do not come close to 100 percent. The variation in the risk perceptions of e-cigarettes across countries is undoubtedly the result of a complex set of factors. Perhaps the only common factor across countries is the research base that governments can draw on to assess the risks of e-cigarettes relative to cigarettes. How this research base is interpreted and contextualized for local relevance, and how it is used by different interest groups, will vary across countries. It is perhaps not surprising that government messaging about the risk of e-cigarettes, is, for lack of a better term, all over the map. However, our research suggests that government messaging about e-cigarettes can have an important impact on individual level risk perceptions.

Our analysis suggests that smokers' misinformation is most striking in countries where government messaging focuses on the risk of e-cigarettes and neglects to compare the risks of e-cigarettes relative to the risks of combustible cigarettes. Government messaging about e-cigarettes should focus on correcting the relative risk misperceptions. Under the Bayesian learning model, misperception comes from imperfect external information and thus could be corrected by providing correct or refined information. Under an anchoring model from behavioral economics, this cannot be fully resolved by correcting information alone, but rather by also having consumers not think about the risks of smoking as an anchor for the risks of e-cigarettes. This poses a fundamental challenge for health messaging to encourage smokers to switch to e-cigarettes. Future research could examine the relevance of the different models of risk perception formation. The rising popularity of nicotine pouches presents a research opportunity. Pouches do not involve inhaling nicotine, so pouch risk perceptions might not be anchored to smoking risk perceptions. If so, it may be easier to generate perceptions that pouches are less or much less harmful than cigarettes. Given recent increases in nicotine pouch sales, this is an area ripe for future research.

Another direction for future research is to explore the roles of public sector versus private sector health messages. To the best of our knowledge, no country currently allows e-cigarette manufacturers to advertise their products as lower risk. For example, even though the U.S. FDA authorizes the sale of some brands of e-cigarettes as appropriate for the protection of public health, the manufacturers are not allowed to make health or smoking cessation claims in advertisements. The FDA has authorized other nicotine products including heated tobacco products and nicotine pouches to make reduced-exposure or reduced-risk claims. Given limited access to private sector information about e-cigarette risks, government messaging plays a key

role in consumer understandings about the absolute and relative risks of e-cigarettes.

Alternatively, the U.S. FDA and other countries' governmental authorities might consider a more permissive approach to private sector messaging, as long as the messages are evidence-based and not misleading.

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TABLE 1: E-Cigarette Government Risk Messaging Across Eight Countries

Country	Messaging	VADER Sentiment Score
Australia	E-cigarettes, also known as vapes, are devices that make vapour for inhalation, simulating cigarette smoking. They are not safe and use can lead to serious health outcomes. They are sometimes marketed as a way to quit smoking, but there is limited evidence to show that they help – or are safe. All e-cigarettes, even those that don't contain nicotine, can contain dangerous substances in the liquids and the aerosol. These can include a number of known cancer-causing agents, such as: • formaldehyde (used in industrial glues and for preserving corpses in hospitals and funeral homes) • acetone (generally found in nail polish remover) • acetaldehyde (used in chemicals, perfumes, and plastics) • acrolein (commonly found in weedkiller) • heavy metals like nickel, tin, and lead. • They can also contain: • propylene glycol – a solvent used in fog/smoke machines • polyester compounds • anti-freeze – used in the coolant of a car • vegetable glycerin – a liquid from vegetable fat. Some chemicals in e-cigarette aerosols can also cause DNA damage. E-cigarettes do not produce the tar found in conventional cigarettes which is the main cause of lung cancer. However, many scientists are concerned that vaping could increase risk of lung disease, heart disease and cancer. Information from: https://www.health.gov.au/topics/smoking-vaping-and-tobacco/about-vaping?language=en#what-are-ecigarettes (accessed June 11th 2024).	-0.9768
China	E-cigarettes are not healthy either There is ample evidence that e-cigarettes are unsafe and harmful to health. For teenagers, e-cigarettes can have adverse consequences on their physical and mental health and growth, and can also induce them to use cigarettes. http://www.nhc.gov.cn/guihuaxxs/s7788/202105/c1c6d17275d94de5a349e379bd755bf1.shtml (accessed June 11, 2024)	-0.2865
United Kingdom	Examples of Statements on UK Health Service Nicotine vaping is substantially less harmful than smoking. It's also one of the most effective tools for quitting smoking. Vaping is not completely harmless and we only recommend it for adult smokers, to support quitting smoking and staying quit. The routines and rituals of smoking can be hard to stop, so vaping can help you gradually let go of these while immediately reducing the health risks of smoking cigarettes. Nicotine itself is not very harmful and has been used safely for many years in medicines to help people stop smoking. Some people find vaping helps them because the hand-to-mouth action is like smoking, plus you get similar sensations, like throat hit (the "kick" in the back of your throat when you inhale). Any smoking is harmful and you will only get the full benefits of vaping if you stop smoking completely. Some people manage to make a full switch very quickly, while for others it can take a bit longer. You're roughly twice as likely to quit smoking if you use a nicotine vape compared with other nicotine replacement products, like patches or gum. Evidence shows that vaping is substantially less harmful than smoking. Vaping exposes users to far fewer toxins and at lower levels than smoking cigarettes.	0.8228

	Switching to vaping significantly reduces your exposure to toxins that can cause cancer, lung disease, and diseases of the heart and circulation like heart attack and stroke. These diseases are not caused by nicotine, which is relatively harmless to health. However, vaping is not risk-free. Non-smokers and young people under 18 should not take up vaping. Did you know? In 2022, UK experts reviewed the international evidence and found that "in the short and medium term, vaping poses a small fraction of the risks of smoking". https://www.nhs.uk/better-health/quit-smoking/vaping-to-quit-smoking/ (accessed June 11th 2024)	
United States	Selected Statements from CDC website • No tobacco products, including e-cigarettes, are safe. • Most e-cigarettes contain nicotine, which is highly addictive and is a health danger for pregnant people, developing fetuses, and youth. • Aerosol from e-cigarettes can also contain harmful and potentially harmful substances. These include cancer-causing chemicals and tiny particles that can be inhaled deep into lungs.¹ • E-cigarettes should not be used by youth, young adults, or people who are pregnant. E-cigarettes may have the potential to benefit adults who smoke and are not pregnant if used as a complete substitute for all smoked tobacco products. • Most e-cigarettes, or vapes, contain nicotine, which has known adverse health effects.¹ • Nicotine is highly addictive.¹ • Nicotine is toxic to developing fetuses and is a health danger for pregnant people. • Acute nicotine exposure can be toxic. Children and adults have been poisoned by swallowing, breathing, or absorbing vaping liquid through their skin or eyes. More than 80% of calls to U.S. poison control centers for e-cigarettes are for children less than 5 years old. • Nicotine poses unique dangers to youth because their brains are still developing. • Nicotine can harm brain development which continues until about age 25. • Youth can start showing signs of nicotine addiction quickly, sometimes before the start of regular or daily use.¹ • Using nicotine during adolescence can harm the parts of the brain that control attention, learning, mood, and impulse control. • Adolescents who use nicotine may be at increased risk for future addiction to other drugs. • Youth who vape may also be more likely to smoke cigarettes in the future. E-cigarette aerosol can contain substances that can be harmful or potentially harmful to the body. These include: • Nicotine, a highly addictive chemical that can harm adolescent brain development • Cancer-causing chemicals • Heavy metals such as nickel, tin, and lead • Tiny particles that can be inhaled deep into the lungs • Volatile organic compounds • Flavorings such as diacetyl, a chemical linked to a serious lung disease. Some flavorings used in e-cigarettes may be safe to eat but not to inhale because the lungs process substances differently than the gut. E-cigarette aerosol generally contains fewer harmful chemicals than the deadly mix of 7,000 chemicals in smoke from cigarettes. However, this does not make e-cigarettes safe. Scientists are still learning about the immediate and long-term health effects of using e-cigarettes. Dual use refers to the use of both e-cigarettes and regular cigarettes. Dual use is not an effective way to safeguard health. It may result in greater exposure to toxins and worse respiratory health outcomes than using either product alone.	-0.953

	Some people who use e-cigarettes have experienced seizures. E-cigarettes can cause unintended injuries. Defective e-cigarette batteries have caused fires and explosions, some of which have resulted in serious injuries. Most explosions happened when the batteries were being charged. https://www.cdc.gov/tobacco/e-cigarettes/health-effects.html (accessed June 11, 2024)	
Japan	No clear statements on health impacts of e-cigarettes were found on the main pages of the Japan Public Health Agency website. https://www.niph.go.jp/en/information-en/ (accessed June 11, 2024)	0
Sweden	Tobacco smoking has decreased in the population since the 1980's, while snus use has increased in recent years after having remained relatively unchanged for a longer period of time. The use of nicotine products, such as nicotine pouches and e-cigarettes, has increased among young people in recent years. All tobacco and nicotine products contain nicotine, which is acutely toxic and highly addictive. The use of tobacco and nicotine products poses health risks. More information about the scientific evidence of the harmful effects of tobacco and nicotine products: Kunskap om tobaks- och nikotinprodukters skadeverkningar – Återredovisning av regeringsuppdrag (in Swedish) Different types of tobacco and nicotine products are sold in Sweden. The products have been on the market for varying lengths of time. Tobacco and nicotine products for smoking include cigarettes, electronic cigarettes (e-cigarettes), cigarillos, roll-your-own tobacco, cigars, pipe tobacco, heated tobacco products (HTP) and water pipe. Snus is a non-smokeable product and includes tobacco snus and nicotine pouches. In recent years, the use of nicotine products, such as nicotine pouches and e-cigarettes, has significantly increased among young people in Sweden. https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/living-conditions-and-lifestyle/andtg/tobacco/ (accessed June 11, 2024).	0.4939
Indonesia	Electronic cigarettes (vape) are as dangerous as conventional cigarettes By: P2PTM RI Ministry of Health https://p2ptm.kemkes.go.id/infographic-p2ptm/penyakit-paru-kronik/page/27/rokok-elektronik-vape-sama-berbahayanya-dengan-rokok-konvensional (accessed June 11, 2024)	-0.4767
Malaysia	Electronic cigarette (e-cigarette) is a device used to heat tobacco products and other smoking substances. It was designed to replace the conventional method of smoking since the year 2000. In Malaysia, this product was introduced in 2013 and became a phenomenal hit in 2016. The prevalence of e-cigarette users in Malaysia aged 18 years and above increased from 3.2% in 2016 (National E-Cigarette Survey; NECS). In 2019, the prevalence of e-cigarette user aged 15 years and above was 4.9% (National Health Morbidity Survey; NHMS). Meanwhile, Tobacco and E-Cigarette Survey among Malaysian Adolescents (TECMA), 2016 documented that 300,000 children and adolescents age 10 to 19 years old used electronic cigarette. The latest survey conducted by University Kebangsaan Malaysia (UKM) in 2018 found that 42.2% of secondary school students in Kuala Lumpur used e-cigarettes, in which 82.2% of them were from the B40 group.	0.2732

Table 2: UK Sample means

	No Message Shown	UK HSA EVALI Message	US CDC EVALI Message	US FDA Youth Message	Total UK
Less harmful	0.53	0.58	0.53	0.50	0.54
Just as harmful or don't know	0.37	0.33	0.37	0.38	0.36
More harmful	0.11	0.096	0.097	0.12	0.10
Perceived e-cigs' relative harm in Likert-type scales (1-5: much less - much more)	2.48	2.42	2.49	2.56	2.49
More expected life years of vapers than smokers	4.57	4.47	4.10	4.00	4.29
Perceived life years lost due to vaping	12.3	12.6	13.4	12.3	12.7
Perceived life years lost due to smoking	16.8	17.1	17.5	16.3	17.0
Considering quitting smoking in the next 6 month switching to e-cigarettes	0.40	0.37	0.36	0.32	0.37
Yes, by switching to smoking cigarettes	0.10	0.12	0.10	0.11	0.11
Considering quitting vaping nicotine-based e-cigarettes in the next 6 months	0.61	0.62	0.66	0.68	0.64
Considering quitting smoking in the next 6 month	0.78	0.75	0.79	0.79	0.78
Trust government agencies for e-cigarettes' health	0.64	0.71	0.68	0.70	0.68
Agree -nicotine in cigarettes is the substance causing most of the cancer	0.20	0.20	0.22	0.22	0.21
No message shown	1	0	0	0	0.25
UK HSA EVALI message	0	1	0	0	0.25
US CDC EVALI message	0	0	1	0	0.25
US FDA youth message	0	0	0	1	0.25
Not remember hearing anything about EVALI or youth vaping epidemic	0.47	0.30	0.29	0.25	0.33
I smoked cigarettes and vaped over the past 30 days	0.38	0.38	0.42	0.36	0.39
I smoked cigarettes only over the past 30 days	0.27	0.27	0.25	0.27	0.26
I vaped e-cigarettes only over the past 30 days	0.34	0.35	0.33	0.37	0.35
Vaping days in past 30 days	16.0	15.6	16.7	15.4	15.9
Average cigarettes smoked daily	6.28	6.37	6.31	6.35	6.33
Age 24 or younger	0.23	0.23	0.23	0.23	0.23
Age 25-34	0.33	0.34	0.34	0.34	0.34
Age 35-44	0.26	0.26	0.25	0.25	0.26
Age 45-54	0.13	0.13	0.12	0.12	0.12
Age 55+	0.061	0.041	0.050	0.061	0.053
Female	0.59	0.57	0.60	0.57	0.58
White	0.74	0.74	0.73	0.77	0.74
Black	0.041	0.043	0.059	0.047	0.048
Asian	0.11	0.11	0.099	0.10	0.11
Other race	0.11	0.10	0.11	0.084	0.10
Observations	1,000	1,000	1,000	1,000	4,000

Notes: Data are from online Cornell surveys conducted November 2022.

Table 3: US Sample means

	No Message Shown	UK HSA EVALI Message	US CDC EVALI Message	US FDA Youth message	Total US
Less harmful	0.26	0.35	0.29	0.27	0.29
Just as harmful or don't know	0.49	0.40	0.41	0.45	0.44
More harmful	0.25	0.25	0.30	0.28	0.27
Perceived e-cigs' relative harm in Likert-type scales (much less - much more)	3.05	2.94	3.07	3.11	3.04
More expected life years of vapers than smokers	0.71	1.11	-0.099	0.19	0.48
Perceived life years lost due to vaping	16.2	18.1	19.9	20.5	18.7
Perceived life years lost due to smoking	16.9	19.2	19.8	20.7	19.1
Considering quitting smoking in the next 6 months by switching to e-cigarettes	0.28	0.29	0.21	0.27	0.26
Yes, by switching to smoking cigarettes	0.16	0.14	0.16	0.11	0.14
Considering quitting vaping nicotine-based e-cigarettes in the next 6 months	0.58	0.63	0.64	0.66	0.63
Considering quitting smoking in the next 6 months	0.64	0.68	0.69	0.70	0.68
Trust government agencies for e-cigarettes' health risks	0.63	0.61	0.67	0.73	0.66
Agree -nicotine in cigarettes is the substance causing most of the cancer	0.24	0.20	0.21	0.19	0.21
No message shown	1	0	0	0	0.25
UK HSA EVALI message	0	1	0	0	0.25
US CDC EVALI message	0	0	1	0	0.25
US FDA youth message	0	0	0	1	0.25
Not remember hearing anything about EVALI or youth vaping epidemic	0.30	0.17	0.18	0.15	0.20
I smoked cigarettes and vaped over the past 30 days	0.34	0.33	0.33	0.37	0.34
I smoked cigarettes only over the past 30 days	0.48	0.48	0.45	0.43	0.46
I vaped e-cigarettes only over the past 30 days	0.18	0.19	0.22	0.20	0.20
Vaping days in past 30 days	10.7	10.6	11.7	12.1	11.2
Average cigarettes smoked daily	10.4	10.3	10.3	9.96	10.2
Age 24 or younger	0.077	0.13	0.14	0.12	0.12
Age 25-34	0.32	0.30	0.32	0.30	0.31
Age 35-44	0.32	0.33	0.30	0.36	0.33
Age 45-54	0.18	0.16	0.15	0.14	0.16
Age 55+	0.097	0.085	0.083	0.078	0.086
Female	0.55	0.55	0.55	0.50	0.54
White	0.57	0.69	0.66	0.69	0.66
Black	0.14	0.17	0.17	0.16	0.16
Asian	0.12	0.047	0.062	0.057	0.071
Other race	0.17	0.091	0.10	0.095	0.11
Observations	1,000	1,000	1,000	1,000	4,000

Notes: Data are from online Cornell surveys conducted November 2022.

Table 4: US sample balance tests

	No Message Shown	UK HSA EVALI Message	US CDC EVALI Message	US FDA Youth Message
I smoked cigarettes only over the past 30 days	0.0063 (0.0239)	-0.0044 (0.0242)	0.011 (0.0242)	-0.013 (0.0242)
I vaped e-cigarettes only over the past 30 days	-0.014 (0.0200)	-0.0053 (0.0202)	0.035 (0.0202)	-0.015 (0.0202)
Vaping days in past 30 days	0.00016 (0.000897)	-0.0013 (0.000907)	0.00042 (0.000908)	0.00072 (0.000907)
Average cigarettes smoked daily	-0.000018 (0.000389)	-0.000086 (0.000394)	0.00036 (0.000394)	-0.00025 (0.000394)
Age 25-34	0.091*** (0.0233)	-0.032 (0.0236)	-0.043 (0.0236)	-0.016 (0.0236)
Age 35-44	0.090*** (0.0236)	-0.030 (0.0239)	-0.069** (0.0239)	0.0091 (0.0238)
Age 45-54	0.13*** (0.0267)	-0.034 (0.0270)	-0.056* (0.0271)	-0.039 (0.0270)
Age 55+	0.13*** (0.0311)	-0.042 (0.0315)	-0.058 (0.0315)	-0.031 (0.0315)
Female	0.018 (0.0137)	0.0054 (0.0138)	0.011 (0.0138)	-0.034* (0.0138)
Black	0.022 (0.0193)	-0.010 (0.0196)	0.011 (0.0196)	-0.023 (0.0195)
Asian	0.20*** (0.0269)	-0.10*** (0.0272)	-0.035 (0.0272)	-0.064* (0.0272)
Other race	0.15*** (0.0218)	-0.070** (0.0221)	-0.026 (0.0221)	-0.058** (0.0221)
Constant	0.11*** (0.0309)	0.31*** (0.0312)	0.28*** (0.0313)	0.30*** (0.0312)
Observations	4,000	4,000	4,000	4,000
Adj R-squared	0.03	0.00	0.00	0.00
Dep Var Mean	0.25	0.25	0.25	0.25

Notes: Data are from online Cornell surveys conducted November 2022. * p<0.05, ** p<0.01, *** p<0.001

Table 5: Impact of Government EVALI Messaging on Risk Perceptions for the United States Sample

	Much less harmful	Less harmful	Just as harmful	More harmful	Much more harmful	I don't know
	b/se	b/se	b/se	b/se	b/se	b/se
UK HSA EVALI message	0.0046 (0.0119)	0.074*** (0.0186)	-0.072** (0.0221)	0.016 (0.0151)	-0.015 (0.0157)	-0.0091 (0.00818)
US CDC EVALI message	0.0088 (0.0118)	0.014 (0.0185)	-0.069** (0.0221)	0.048** (0.0151)	0.0034 (0.0157)	-0.0057 (0.00817)
US FDA youth message	-0.012 (0.0119)	0.0038 (0.0186)	-0.020 (0.0221)	0.012 (0.0152)	0.027 (0.0157)	-0.0098 (0.00820)
Age 25-34	0.011 (0.0142)	-0.040 (0.0223)	-0.0028 (0.0265)	0.0036 (0.0182)	0.038* (0.0189)	-0.0093 (0.00982)
Age 35-44	0.012 (0.0143)	-0.057* (0.0223)	0.016 (0.0266)	0.0067 (0.0182)	0.029 (0.0189)	-0.0071 (0.00985)
Age 45-54	-0.019 (0.0161)	-0.067** (0.0253)	0.0095 (0.0301)	0.0089 (0.0206)	0.066** (0.0214)	0.0013 (0.0111)
Age 55+	-0.00062 (0.0188)	-0.065* (0.0295)	0.053 (0.0351)	0.0045 (0.0240)	0.019 (0.0249)	-0.011 (0.0130)
Female	-0.0062 (0.00839)	-0.057*** (0.0131)	0.066*** (0.0156)	-0.020 (0.0107)	0.0084 (0.0111)	0.0091 (0.00579)
Black	-0.020 (0.0118)	-0.066*** (0.0185)	0.015 (0.0220)	0.010 (0.0151)	0.064*** (0.0156)	-0.0038 (0.00814)
Asian	0.0029 (0.0166)	-0.0024 (0.0260)	-0.014 (0.0309)	-0.020 (0.0212)	0.013 (0.0220)	0.021 (0.0114)
Other race	0.0032 (0.0134)	-0.042* (0.0210)	0.016 (0.0251)	-0.026 (0.0172)	0.045* (0.0178)	0.0029 (0.00928)
Education: University+	0.0047 (0.00843)	0.040** (0.0132)	-0.024 (0.0157)	0.014 (0.0108)	-0.012 (0.0112)	-0.022*** (0.00581)
Constant	0.073*** (0.0167)	0.27*** (0.0261)	0.40*** (0.0311)	0.11*** (0.0213)	0.089*** (0.0221)	0.051*** (0.0115)
Observations	4,000	4,000	4,000	4,000	4,000	4,000
Adj R-squared	0.00	0.02	0.01	0.00	0.01	0.00
Dep Var Mean	0.07	0.22	0.40	0.13	0.14	0.03

Source: Online Cornell surveys Nov. 2022. Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 5a: The Impact of Government Messaging on Risk Perceptions for the United States Sample with Education Interaction Terms

	Much less harmful	Less harmful	Just as harmful	More harmful	Much more harmful	Don't know
	b/se	b/se	b/se	b/se	b/se	b/se
UK HSA EVALI message	0.00051 (0.0159)	0.064** (0.0249)	-0.051 (0.0296)	0.015 (0.0203)	-0.029 (0.0211)	0.00064 (0.0110)
US CDC EVALI message	-0.00072 (0.0158)	0.0068 (0.0248)	-0.057 (0.0295)	0.051* (0.0202)	-0.0034 (0.0210)	0.0031 (0.0109)
US FDA youth message	-0.029 (0.0166)	0.0052 (0.0260)	0.0092 (0.0310)	0.012 (0.0213)	0.019 (0.0221)	-0.016 (0.0115)
Education: University+	-0.012 (0.0167)	0.031 (0.0262)	0.0088 (0.0312)	0.015 (0.0214)	-0.028 (0.0222)	-0.015 (0.0115)
UK HSA EVALI message x Education: University+	0.0098 (0.0236)	0.022 (0.0370)	-0.047 (0.0440)	0.0036 (0.0302)	0.033 (0.0313)	-0.022 (0.0163)
US CDC EVALI message x Education: University+	0.022 (0.0236)	0.016 (0.0370)	-0.026 (0.0441)	-0.0067 (0.0302)	0.015 (0.0313)	-0.020 (0.0163)
US FDA youth message x Education: University+	0.035 (0.0236)	-0.00073 (0.0370)	-0.060 (0.0441)	-0.0014 (0.0302)	0.017 (0.0313)	0.011 (0.0163)
Age 25-34	0.011 (0.0142)	-0.041 (0.0223)	-0.0026 (0.0265)	0.0037 (0.0182)	0.038* (0.0189)	-0.0089 (0.00982)
Age 35-44	0.011 (0.0143)	-0.057* (0.0224)	0.017 (0.0266)	0.0069 (0.0183)	0.029 (0.0189)	-0.0066 (0.00986)
Age 45-54	-0.019 (0.0162)	-0.067** (0.0253)	0.0091 (0.0301)	0.0090 (0.0206)	0.066** (0.0214)	0.0015 (0.0111)
Age 55+	-0.00071 (0.0188)	-0.065* (0.0295)	0.053 (0.0351)	0.0046 (0.0240)	0.020 (0.0250)	-0.011 (0.0130)
Female	-0.0060 (0.00840)	-0.057*** (0.0131)	0.066*** (0.0156)	-0.020 (0.0107)	0.0085 (0.0111)	0.0092 (0.00579)
Black	-0.020 (0.0118)	-0.066*** (0.0185)	0.014 (0.0220)	0.011 (0.0151)	0.065*** (0.0156)	-0.0038 (0.00814)
Asian	0.0036 (0.0166)	-0.0023 (0.0260)	-0.015 (0.0309)	-0.020 (0.0212)	0.013 (0.0220)	0.021 (0.0114)
Other race	0.0040 (0.0135)	-0.042* (0.0211)	0.015 (0.0251)	-0.026 (0.0172)	0.046* (0.0178)	0.0028 (0.00929)
Constant	0.081*** (0.0179)	0.27*** (0.0280)	0.39*** (0.0334)	0.11*** (0.0229)	0.096*** (0.0237)	0.047*** (0.0123)
Observations	4,000	4,000	4,000	4,000	4,000	4,000
Adj R-squared	0.00	0.01	0.01	0.00	0.01	0.00
Dep Var Mean	0.07	0.22	0.40	0.13	0.14	0.03

Source: Online Cornell surveys Nov. 2022. Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 6: Impact of Government EVALI Messaging on Risk Perceptions for the U.K. Sample

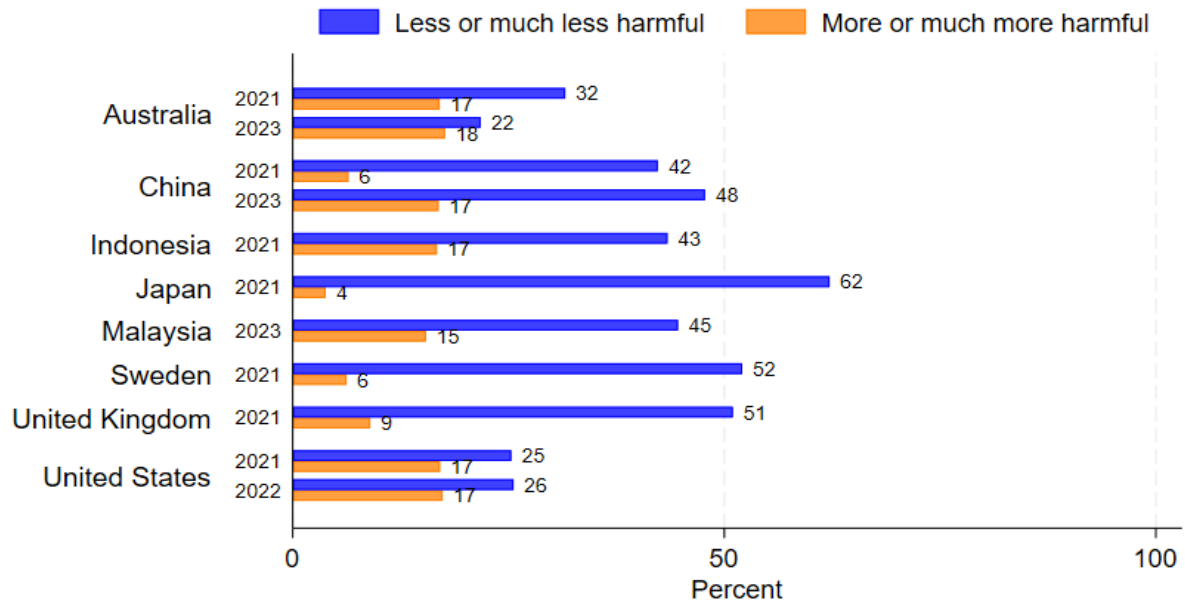
	Much less harmful	Less harmful	Just as harmful	More harmful	Much more harmful	Don't know
	b/se	b/se	b/se	b/se	b/se	b/se
UK HSA EVALI message	0.0024 (0.0145)	0.047* (0.0220)	-0.042* (0.0210)	-0.0081 (0.0110)	-0.0025 (0.00864)	0.0036 (0.00811)
US CDC EVALI message	-0.019 (0.0145)	0.024 (0.0220)	0.0045 (0.0209)	-0.012 (0.0110)	0.0019 (0.00864)	0.00014 (0.00811)
US FDA youth message	-0.027 (0.0145)	0.00085 (0.0220)	0.022 (0.0210)	-0.0019 (0.0110)	0.012 (0.00864)	-0.0071 (0.00811)
Age 25-34	0.013 (0.0140)	0.036 (0.0213)	-0.041* (0.0203)	-0.011 (0.0106)	-0.0023 (0.00836)	0.0055 (0.00784)
Age 35-44	0.022 (0.0150)	0.087*** (0.0227)	-0.064** (0.0216)	-0.044*** (0.0113)	-0.011 (0.00892)	0.011 (0.00837)
Age 45-54	0.048** (0.0184)	0.074** (0.0278)	-0.076** (0.0265)	-0.026 (0.0139)	-0.022* (0.0109)	0.0020 (0.0103)
Age 55+	0.076** (0.0252)	0.023 (0.0381)	-0.072* (0.0363)	-0.039* (0.0190)	0.0017 (0.0150)	0.0099 (0.0141)
Female	-0.029** (0.0105)	0.0093 (0.0159)	0.022 (0.0152)	0.0026 (0.00794)	-0.014* (0.00625)	0.0086 (0.00587)
Black	-0.015 (0.0247)	-0.030 (0.0374)	-0.014 (0.0357)	0.070*** (0.0187)	-0.0015 (0.0147)	-0.0087 (0.0138)
Asian	-0.0019 (0.0172)	-0.038 (0.0260)	0.013 (0.0248)	0.033* (0.0130)	0.019 (0.0102)	-0.025** (0.00959)
Other race	-0.0100 (0.0172)	-0.016 (0.0261)	-0.013 (0.0249)	0.013 (0.0130)	0.044*** (0.0103)	-0.018 (0.00963)
Education: Post Grad Or University	0.0062 (0.0106)	0.045** (0.0161)	-0.042** (0.0153)	-0.012 (0.00802)	0.0090 (0.00632)	-0.0061 (0.00593)
Constant	0.13*** (0.0166)	0.33*** (0.0252)	0.38*** (0.0240)	0.086*** (0.0126)	0.040*** (0.00989)	0.032*** (0.00928)
Observations	4,000	4,000	4,000	4,000	4,000	4,000
Adj R-squared	0.00	0.01	0.01	0.01	0.01	0.00
Dep Var Mean	0.12	0.41	0.33	0.06	0.04	0.03

Table 6a: The Impact of Government Messaging on Risk Perceptions for the United Kingdom Sample with Education Interaction Terms

	Much less harmful	Less harmful	Just as harmful	More harmful	Much more harmful	I don't know
	b/se	b/se	b/se	b/se	b/se	b/se
UK HSA EVALI message	-0.0056 (0.0191)	0.066* (0.0289)	-0.061* (0.0275)	0.0017 (0.0144)	0.0039 (0.0114)	-0.0052 (0.0107)
US CDC EVALI message	-0.028 (0.0189)	0.031 (0.0287)	0.00044 (0.0273)	-0.0017 (0.0143)	0.0033 (0.0113)	-0.0047 (0.0106)
US FDA youth message	-0.030 (0.0190)	0.012 (0.0288)	0.012 (0.0275)	0.0011 (0.0144)	0.020 (0.0113)	-0.014 (0.0106)
Education: University+	-0.0070 (0.0210)	0.067* (0.0319)	-0.062* (0.0304)	0.0025 (0.0159)	0.018 (0.0125)	-0.019 (0.0117)
UK HSA EVALI message x Education: University+	0.020 (0.0295)	-0.045 (0.0446)	0.043 (0.0425)	-0.024 (0.0223)	-0.015 (0.0175)	0.021 (0.0165)
US CDC EVALI message x Education: University+	0.023 (0.0295)	-0.016 (0.0447)	0.011 (0.0426)	-0.026 (0.0223)	-0.0041 (0.0176)	0.012 (0.0165)
US FDA youth message # Education: University+	0.010 (0.0295)	-0.027 (0.0447)	0.025 (0.0425)	-0.0083 (0.0223)	-0.017 (0.0175)	0.017 (0.0165)
Age 25-34	0.013 (0.0140)	0.037 (0.0213)	-0.042* (0.0203)	-0.011 (0.0106)	-0.0021 (0.00836)	0.0052 (0.00785)
Age 35-44	0.022 (0.0150)	0.087*** (0.0227)	-0.064** (0.0217)	-0.044*** (0.0113)	-0.011 (0.00893)	0.011 (0.00838)
Age 45-54	0.048** (0.0184)	0.074** (0.0278)	-0.076** (0.0265)	-0.026 (0.0139)	-0.022* (0.0109)	0.0020 (0.0103)
Age 55+	0.076** (0.0252)	0.023 (0.0381)	-0.072* (0.0363)	-0.039* (0.0190)	0.0014 (0.0150)	0.010 (0.0141)
Female	-0.029** (0.0105)	0.0090 (0.0159)	0.023 (0.0152)	0.0025 (0.00794)	-0.014* (0.00626)	0.0087 (0.00587)
Black	-0.015 (0.0247)	-0.030 (0.0375)	-0.014 (0.0357)	0.069*** (0.0187)	-0.0013 (0.0147)	-0.0088 (0.0138)
Asian	-0.0020 (0.0172)	-0.037 (0.0260)	0.013 (0.0248)	0.033* (0.0130)	0.019 (0.0102)	-0.025** (0.00959)
Other race	-0.0097 (0.0173)	-0.017 (0.0262)	-0.012 (0.0249)	0.012 (0.0130)	0.044*** (0.0103)	-0.017 (0.00964)
Constant	0.13*** (0.0181)	0.33*** (0.0275)	0.39*** (0.0262)	0.080*** (0.0137)	0.037*** (0.0108)	0.037*** (0.0101)
Observations	4,000	4,000	4,000	4,000	4,000	4,000
Adj R-squared	0.00	0.01	0.00	0.01	0.01	0.00
Dep Var Mean	0.12	0.41	0.33	0.06	0.04	0.03

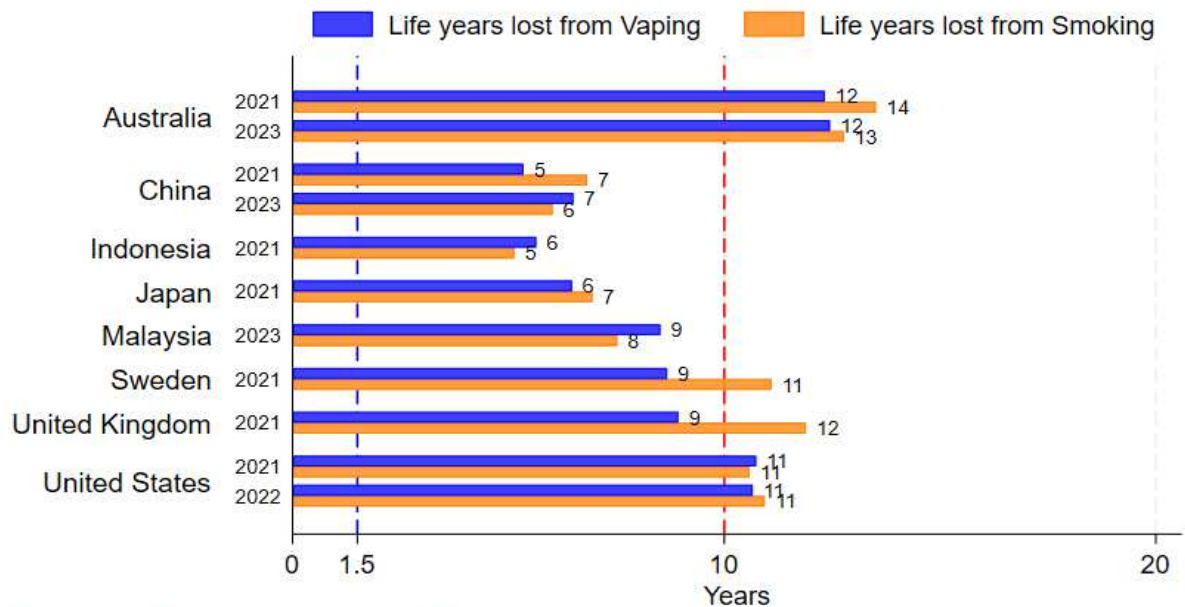
Source: Online Cornell surveys Nov. 2022. Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Figure 1: Misperceptions of E-Cigarette Risk Relative to Cigarettes



Source: Cornell online cross-country surveys 11/2021-4/2023. Heated sticks for JP. N is between 600-650 for all samples except 2021 US (1,202) or 2023 MY (693).

Figure 2: Perceived Life Years Lost Due to Smoking and Vaping



Source: Cornell online cross-country surveys 11/2021-4/2023. N is between 600-650 for all samples except 2021 US (1,202) or 2023 MY (693).

Figure 3: US EVALI Message



Lung injury assoc. w/ e-cigarette product use/vaping was recently reported in most states. CDC & others continuing to investigate. CDC recommends considering refraining from using e-cigarette/vaping products, especially those with THC. New @CDCMMWR : bit.ly/MMWRLungInjury

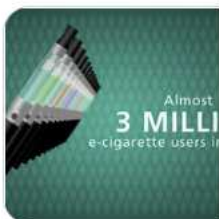


4:58 AM · Sep 28, 2019 · Twitter Web Client

Figure 4: UK EVALI Message



Our advice on e-cigarettes remains unchanged - vaping isn't completely risk free but is far less harmful than smoking tobacco. There is no situation where it would be better for your health to continue smoking rather than switching completely to vaping



ukhsa.blog.gov.uk
Clearing up some myths around e-cigarettes
Not surprisingly, there are lots of inaccuracies and misconceptions about e-cigarettes and vaping. This blog ...

12:11 AM · Sep 13, 2019 · Twitter Web App

Figure 5: US FDA Youth Epidemic Message



U.S. FDA

@US_FDA · Follow



Today, @POTUS announced that as part of its ongoing work to tackle the youth e-cigarette epidemic, FDA intends to finalize a compliance policy soon that prioritizes enforcement of premarket authorization requirements for non-tobacco-flavored e-cigarettes. go.usa.gov/xVRBC



2:05 PM · Sep 11, 2019

