



## Perceived risk of electronic cigarettes compared to combustible cigarettes: direct versus indirect questioning

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### Keywords

electronic nicotine delivery systems; tobacco products; risk; perception

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While smoking rates have decreased (from 20.9% of US adults in 2005<sup>1</sup> to 14.0% in 2017<sup>2</sup>), tobacco companies have responded by introducing alternative tobacco products, such as electronic cigarettes (e-cigarettes) into the global market.<sup>3</sup>

Tobacco companies claim a need for messaging that informs the public of relative risks of alternative tobacco products compared to traditional combustible cigarettes.<sup>4,5</sup> In order to be able to market alternative tobacco products with reduced risk claims in the US, tobacco companies must submit a Modified Risk Tobacco Product (MRTP) application with evidence demonstrating that “the product will or is expected to benefit the health of the population as a whole.”<sup>6,7</sup> As of March 2020, there have been five sets of MRTP applications accepted for review by the FDA for various tobacco products, and companies have expressed intentions to submit MRTP applications for e-cigarettes.<sup>8</sup>

In the current MRTP applications, tobacco companies allege consumers overestimate the risk of potential MRTPs.<sup>9,10</sup> They cited previous studies by independent researchers showing that a large proportion of the population perceives potential MRTPs as equally or more harmful than cigarettes, and argue misperceptions need to be corrected using modified

risk claims.<sup>11–15</sup> However, the studies cited predominantly used one specific measurement of comparative risk referred to as the direct questioning approach, utilizing a single question to measure relative risk (e.g., “Compared to cigarettes, is product X less harmful, equally harmful, or more harmful?”). An alternative approach that uses indirect questioning (respondents answer separate questions measuring absolute risk perceptions of two products and then these ratings are compared) results in a larger proportion of respondents assessing alternative nicotine products as less harmful than cigarettes.<sup>16,17</sup>

Several studies have compared direct and indirect relative risk perceptions between cigarettes and other tobacco products.<sup>18–20</sup> However, these studies were conducted prior to 2017, when pod-based e-cigarettes that use nicotine salts were less prevalent. The product landscape and patterns and prevalence of product use have changed significantly since then. Few studies that explored perceptions of harm related to pod-based devices are available.<sup>21,22</sup> Therefore, up-to-date research is needed in order to elucidate whether perceptions have changed along with the emergence of novel e-cigarettes. As products continue to change, there remains a need to better understand how to accurately assess perceptions of e-cigarette harms.<sup>17</sup> We extend the current literature comparing these two approaches for measuring risk perceptions to a more recent, representative sample of US adult smokers and non-smokers and include a category for those that responded “I don’t know” (which was rarely included in the previous studies<sup>23</sup>). The goal is to enhance understanding of the difference between direct and indirect risk perceptions in relation to cigarette and e-cigarette use.

## Methods

The data come from the 2017 Tobacco Products and Risk Perceptions Survey, a national cross-sectional survey of adults aged 18 and older in the US. The survey was administered online in August – September 2017 by GfK, an independent market research group. Of the 8229 invited panelists selected with probabilities proportional to size after application of the panel demographic poststratification weight, 6033 (73.3%) were “qualified completers”. After data cleaning, 5992 participants were retained for analyses (see Nyman et al., 2018).<sup>24</sup>

Perceived comparative risk was measured in two ways: direct (single question) and indirect (separately for each product). The direct question asked: “Is using electronic vapor products less harmful, about the same, or more harmful than smoking regular cigarettes?” Answers were categorized as less harmful (“much less harmful” and “less harmful” combined), equally harmful (“about the same level of harm”), more harmful (“more harmful” and “much more harmful”) and “I don’t know”.

For the indirect measure, participants were asked the same question for cigarettes and e-cigarettes: “Imagine that you just began smoking cigarettes [using electronic vapor products] every day. What do you think your chances are of having each of the following happen to you if you continue to smoke cigarettes [use electronic vapor products] every day?: (1) Lung Cancer; (2) Lung disease other than lung cancer (such as COPD and emphysema); (3) Heart disease; (4) Early/Premature Death.” Responses ranged from ‘0 – No chance’ to ‘6 – Very good chance’ or participants could respond “I don’t know.” For each participant, we created a perceived harm of cigarettes score by averaging the items related to risk of cigarette harms

and, similarly, a perceived harm of e-cigarettes score. We then subtracted the perceived harm of e-cigarettes from perceived harm of cigarettes to get an indirect comparative harm score. We recoded the scores into three categories: e-cigarettes as “less harmful”, “equally harmful” and “more harmful” than cigarettes. Only participants who answered “I don’t know” to all four questions related to cigarette harms and/or all four e-cigarette harms were categorized as “Don’t Know”. Analyses were conducted using IBM SPSS with the Complex Samples module (V.25).<sup>25</sup>

## Results

When asked to compare harms of e-cigarettes and cigarettes directly (one question), 33.9% (95% CI 32.5% to 35.5%) of participants identified e-cigarettes as *less harmful* than cigarettes, 36.4% (95% CI 34.9% to 38.0%) reported *equal harm*, 4.3% (95% CI 3.7% to 5.0%) said e-cigarettes were *more harmful*, and 25.3% (95% CI 24.0% to 26.7%) didn’t know (Figure 1). When asked indirectly (separate questions), 42.1% (95% CI 40.4% to 43.7%) identified e-cigarettes as *less harmful* than cigarettes, 23.8% (95% CI 22.4% to 25.3%) reported *equal harm*, 7.1% (95% CI 6.2% to 8.0%) perceived e-cigarettes to be *more harmful* and 27.1% (95% CI 25.7% to 28.6%) didn’t know. The mean indirect score for all participants was  $-0.95$  (95% CI  $-1.0$  to  $-0.89$ ) indicating that on average, smokers and non-smokers in the U.S. perceive e-cigarettes as less harmful than cigarettes. The correlation between the indirect and direct comparative risk scores was 0.4 (Spearman’s rho,  $p < 0.001$ ).

When examined by smoking status (self-reported as current smoker [smoked 100 cigarettes in his/her lifetime and currently smokes some days or every day], former smoker, or never smoker) the results are similar for all groups (see Supplemental Materials), suggesting that adults, regardless of tobacco use history, are more likely to assess e-cigarettes as less harmful than cigarettes when asked indirectly than when asked to make a direct comparison in a single question.

We conducted a sensitivity analysis to assess whether this finding changed when we increased the range of difference values classified “equally harmful” for the indirect approach from exactly zero to a range from  $-0.5$  to  $0.5$ . This re-classification altered the results: 35.4% (95% CI 33.9% to 37.0%) identified e-cigarettes as *less harmful* than cigarettes, 33.7% (95% CI 32.2% to 35.3%) said they were of *equal harm*, and 3.7% (95% CI 3.1% to 4.4%) perceived e-cigarettes to be *more harmful* (see Supplemental Materials).

## Discussion

We found that the estimated proportion of US adults that perceive using e-cigarettes as less harmful than smoking cigarettes depended on whether an indirect measure (42.1%) or direct measure (33.9%) was used and that the two measures were only moderately correlated. This finding supports that public knowledge of the potential harms of e-cigarettes is limited. This is also consistent with the current state of the literature, which is lacking evidence on the long-term health impacts.<sup>26–28</sup>

The discrepancy we found between the direct and indirect measures was less pronounced than in other studies.<sup>19,20</sup> The greater discrepancies found in or inferred by prior research

might be due less to inherent differences between indirect and direct approaches and more to whether studies allowed a “don’t know” response or how they implemented the indirect approach (e.g., the scale for the absolute harm/risk measures). Recent research has shown that, even when asked indirectly, the percentage of US adults who perceive e-cigarettes as less harmful than cigarettes is smaller than in previous studies, suggesting the public’s perceptions of e-cigarette harms may be changing over time.<sup>29</sup>

The differences in how the questions used to measure direct and indirect perceptions could have changed how the participants interpreted and responded to the questions, as demonstrated by the moderate correlation in both the main analysis (Spearman’s rho = 0.42) and the sensitivity analysis (Spearman’s rho = 0.43).

## Limitations

We were limited by the direct and indirect questions used in the survey. We calculated the indirect risk score using an average of the four health risks to increase comparability with the direct risk question. The categorization for indirect questions could be done differently and we conducted sensitivity analyses for one alternative way for calculating the “equally harmful” category and presented the raw indirect scores in the Supplement for transparency.

## Conclusion

Our study, combined with the previous literature, suggests the need to utilize both direct and indirect risk questions when assessing the public’s perceptions of harms of novel tobacco products. Tobacco companies and researchers that maintain the position that adults do not understand the reduced harm of e-cigarettes should consider reporting on both on the indirect and direct responses to comparative harms questions. This is particularly pertinent to the MRTP applications; those that only provide one type of comparative risk measurement may not capture the full picture of risk perceptions and may hinder regulators from properly evaluating the population-level impact of the modified risk tobacco products.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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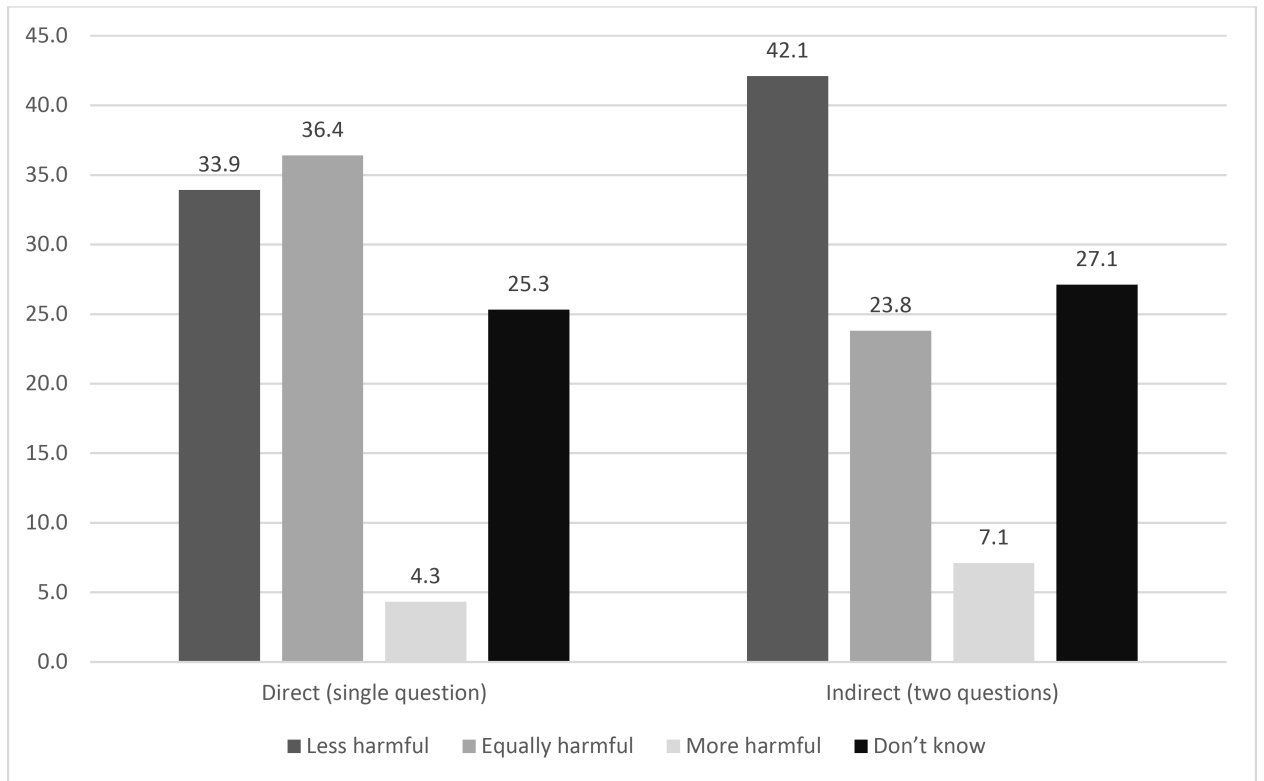
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**Figure 1:**  
Direct Comparative Risk (one-question) compared to Indirect Comparative Risk (twoquestions) of e-cigarette harms compared to cigarettes among all participants (current smokers, former smokers, and never smokers)