

# How do consumers perceive differences in risk across nicotine products? A review of relative risk perceptions across smokeless tobacco, e-cigarettes, nicotine replacement therapy and combustible cigarettes

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## ABSTRACT

**Objective** To systematically review the literature regarding relative risk perceptions (RRPs) across non-combustible nicotine products.

**Data sources** MEDLINE and PsycINFO databases were searched for articles published up to October 2014.

**Study selection** Of the 5266 records identified, articles not published in English that did not quantitatively assess RRP across categories of non-combustible nicotine products were excluded, yielding 55 records.

**Data extraction** One reviewer extracted measures and findings of RRP for product comparisons of smokeless tobacco (SLT), e-cigarettes (ECs) and nicotine replacement therapy (NRT) to one another, and to combustible cigarettes (CCs).

**Data synthesis** A total of 157 samples from 54 studies were included in the analyses. The accuracy of RRP differed based on the products being compared: although the accuracy of RRP was variable across studies, substantial proportions of respondents reported inaccurate beliefs about the relative harmfulness of SLT versus CCs, as well as of ECs versus NRT. In addition, in most studies, respondents did not know the relative harmfulness of SLT versus NRT. In contrast, respondents in many studies correctly perceived NRT and ECs as less harmful than CCs. Cigarette smokers and users of non-combustible nicotine products tended to correctly perceive the relative harmfulness of products more often than non-users. Measures used to assess RRP varied across studies, with different approaches characterised by certain strengths and limitations.

**Conclusions** The highly variable and context-specific nature of non-combustible nicotine product RRP have direct implications for researchers and present several challenges for policymakers working with modified risk products, including issues of measurement, health risk communication and behaviour change.

## INTRODUCTION

Tobacco and nicotine products fall on a continuum of risk based on the mode of nicotine delivery and product constituents.<sup>1</sup> Combustible cigarettes (CCs) are most hazardous, due to the high number of toxic constituents in smoke and the highly efficient delivery of nicotine. The least hazardous are nicotine replacement therapy (NRT) products, which deliver nicotine with fewer toxic by-products and have been evaluated for clinical safety and efficacy. Various non-combustible products fall between CCs and NRT, including smokeless tobacco (SLT) and electronic cigarettes (ECs).<sup>1 2</sup>

Smokeless tobacco products are available in many forms, including chewing tobacco, snuff, snus and dissolvable tobacco products, and may be used orally or nasally.<sup>2 3</sup> Use of SLT products can cause addiction, precancerous oral lesions and cancer of the oral cavity, oesophagus and pancreas, as well as adverse reproductive effects, and is associated with increased risk of ischaemic heart disease, stroke and diabetes.<sup>3</sup> Although the health risks posed by SLT use can vary by product, in general, they are lower relative to those of combusted tobacco.<sup>2 4</sup> E-cigarettes are highly variable products that deliver nicotine via an aerosol and may contain additives and flavours.<sup>5</sup> Although evidence to date indicates that ECs are likely to pose substantially less risk than CCs, the long-term health effects of these products remain unknown.<sup>5-7</sup>

The combined effects of tobacco control policies and technological innovation have created a very distinct nicotine market. The changing landscape presents SLT and ECs as modern, acceptable alternatives, creating new challenges for public health. While non-combustible nicotine products are likely to pose fewer risks to individual users, the impact of these products on public health will be determined by their effect on smoking prevalence.<sup>8 9</sup>

Consumer perceptions of risk have played a fundamental role in reducing the prevalence of smoking over the past 50 years. Concerns about the health risks of smoking are the most common motivation to quit smoking as reported by current and former smokers<sup>10-13</sup> and play a protective role against youth initiation of smoking.<sup>14</sup> Consumer risk perceptions for emerging products will also have an important influence on how emerging nicotine products are used and by whom.

The dominant public health message in many countries is that there is no safe tobacco product.<sup>15 16</sup> This message has been promoted by major public health authorities, including websites in the USA, such as those of the Centers for Disease Control and Prevention (CDC) and the National Cancer Institute (NCI), among others.<sup>17 18</sup> Although factually true, this message does not reflect the epidemiological evidence supporting the differential risks of tobacco products, and may lead to inaccurate perceptions of relative risks of tobacco products.<sup>15</sup> In addition, lack of proactive public health communication effectively means that the industry controls information related to product design and consumer behaviour.<sup>1</sup>

There is a need for more effective health risk communication concerning nicotine products.

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Public health authorities require evidence on how consumers perceive the relative risk of different products to guide labelling policies and risk communication efforts. For instance, the US Food and Drug Administration (FDA) considers applications from manufacturers who seek to market 'modified risk products' and wish to use messaging that a given product poses fewer health risks than a reference product.<sup>15–19</sup> There is also a need to develop the research methodology for assessing perceptions of relative risk, given that past assessments have been inconsistent. To date, however, there has been no systematic review of evidence concerning relative risk perceptions (RRPs) across the nicotine spectrum. The current review aims to examine the evidence regarding RRP of non-combustible nicotine products; describe the methods of assessment of RRP; and discuss implications for public health policy.

## METHODS

### Search strategy

One investigator searched MEDLINE and PsycINFO in October 2014 for all published articles using a search strategy built on three key concepts: risk, perception and nicotine products (see Supplementary table S1).

### Study selection

Identified articles were reviewed to determine eligibility according to the following criteria: were original empirical investigations; quantitatively assessed RRP across categories of nicotine products (eg, SLT vs CCs); and were published in English in peer-reviewed journals. The review was limited to examination of RRP for product comparisons of SLT (chew, dip, snuff, snus, dissolvables), ECs and NRT (gum, patch, lozenge) to one another, and to CCs. Potentially reduced exposure products and fringe products (eg, nicotine lollipops, tobacco heat sticks) were excluded. The removal of duplicates (n=211) resulted in 5266 unique records. As outlined in [figure 1](#), further assessment yielded 55 final records. Of these, two pairs of records<sup>20</sup> and <sup>21, 22</sup> and <sup>23</sup> reported findings from the same study; as a result, these were paired together. In addition, one record<sup>24</sup> reported findings from two distinct surveys; as a result, this record was split (denoted as <sup>24A, 24B</sup> in Supplementary table 2). Thus, a total of 55 records (54 studies from 55 articles) were included in the analysis.

### Data extraction

A data extraction table was used to summarise the study findings. Measures of RRP were extracted from the identified studies as follows. First, question stems were categorised as either 'closed judgements', in which a particular RRP was presented as a statement and solicited respondents' evaluation of this judgement; or 'open questions', which allowed respondents to select a RRP from a list. Second, response options were classified as either 'categorical', eliciting a discrete choice from respondents; 'continuous', allowing respondents to select an answer from a continuum or range of options; or 'mixed', involving a combination of categorical and continuous dimensions. Measures consisting of a continuous response were further classified as using a rating technique, requiring respondents to indicate the degree of a particular attribute or the degree to which they endorse an attitude; or a ranking technique, requiring respondents to place in order a series of alternatives.<sup>25</sup>

Results were summarised as comparisons made across products, denoted as X versus Y (reference), using mathematical operators. Findings for the full sample and any subsamples related to use of nicotine products were recorded. Users of CCs

included both former smokers (individuals who had smoked at least 100 cigarettes in their lifetime but had not smoked in the past 30 days) and current smokers (individuals who had smoked at least 100 cigarettes in their lifetime and had smoked in the past 30 days). Users of non-combustible nicotine products included individuals who had ever used such a product in their lifetime.

### Data synthesis

Results were analysed using the narrative synthesis approach.<sup>26</sup> Specifically, results were categorised by product comparisons across nicotine product classes: NRT versus CCs, SLT versus CCs, SLT versus NRT, ECs versus CCs and ECs versus NRT. Within each product comparison, RRP were examined overall, as well as with respect to several samples: general samples (ie, non-targeted recruitment), cigarette smokers and users of non-combustible nicotine products. The variability of RRP across samples was described in terms of whether a discernable majority of respondents in each sample (51% or greater) held a particular RRP. The findings were categorised as follows: a majority of respondents held a particular RRP (eg, perception of a product as having less risk than a reference product), or they did not know the relative risk between given products. In addition, samples in which a particular RRP was not held by a majority of respondents were classified as 'none', and samples for which insufficient information was given to discern whether a majority of respondents held a particular RRP were classified as 'unknown'. These findings were examined overall across all study samples and stratified by the sampling method. Other quantitative findings that did not represent proportions of respondents who held particular RRP were considered separately. Finally, the findings were examined with respect to whether they accurately reflected the epidemiological continuum of risk.

## RESULTS

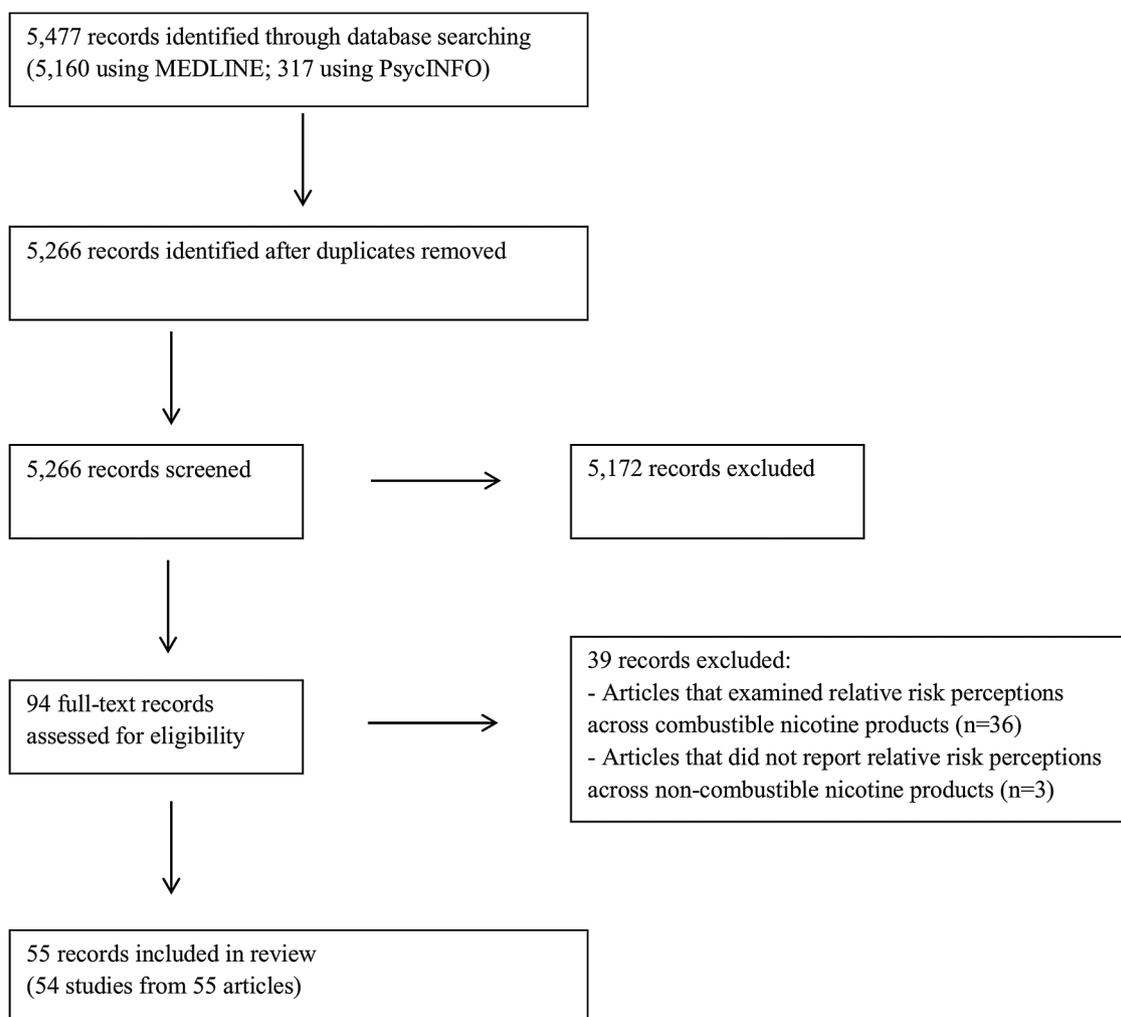
In all, 54 studies met the inclusion criteria. A majority of studies were observational in nature (n=52), including cross-sectional surveys (n=48) and longitudinal studies (n=4), while two studies were experimental. The studies were conducted between 1983 and 2013 in various countries, with a majority of studies in the USA (n=31). A majority of the observational studies used probability-based sampling methods (n=35), while both experimental studies used non-probability-based sampling methods (n=2). Several studies purposively recruited nicotine product users, including users of CCs (n=21), ECs (n=4) and SLT (n=1). A detailed description of the studies is available online (see Supplementary table S2).

### RRPs by product comparison

Perceptions of relative risk appeared to be specific to particular product comparisons across the non-combustible nicotine spectrum. [Table 1](#) shows the proportion of samples in which a majority of respondents held a particular RRP for each product comparison (see Supplementary table S3 for findings stratified by sampling method).

#### SLT versus CCs

RRPs for comparisons of SLT with CCs were examined in 83 samples from 30 studies.<sup>27–56</sup> Among the observational study samples (n=77), RRP of SLT versus CCs were highly variable: in 18% and 13% of samples, a majority of respondents perceived SLT to be less harmful than CCs, and SLT to be as harmful as CCs, respectively. Further, in about one-quarter of



**Figure 1** PRISMA flow chart.

samples (27%) there was no discernible majority RRP, while in about one-third of samples (32%), there was insufficient information to ascertain whether a majority of respondents held a particular RRP. The pattern of findings among probability-based (n=56) and non-probability-based (n=21) samples generally agreed with those described above (when RRP of 'less' and 'less or equal' for non-probability-based samples are combined). In addition, Smith and colleagues found that respondents in their study ranked SLT as significantly less harmful than CCs.<sup>45</sup> When RRP were compared with objective risks, the epidemiologically correct RRP was held by a majority of respondents in just 18% of samples.

#### ECs versus CCs

RRPs of ECs versus CCs were examined in 50 samples from 23 studies.<sup>22 and 23 24A 24B 50 53 56 57-73</sup> In 70% of observational study samples (n=46), a majority of respondents perceived ECs as less harmful than CCs; while in 17% of samples, no clear RRP emerged among a majority of respondents. Among samples recruited using probability-based methods (n=32), this pattern was generally consistent, albeit a majority of respondents perceived ECs as less harmful than CCs in a smaller proportion of samples, while a majority of respondents held this RRP in all non-probability-based samples (n=14). In addition, Harrell *et al*<sup>69</sup> and Pokhrel *et al*<sup>73</sup> reported that respondents in their studies perceived ECs as less harmful than CCs. With respect to

the epidemiological continuum of risk, respondents correctly perceived ECs as less harmful than CCs in most studies.

#### NRT versus CCs

RRPs for this product comparison were examined in 20 samples from 8 studies.<sup>20 and 21 31 33 42 46 74-76</sup> Although in approximately one-third of samples (35%), a majority of respondents viewed NRT as less harmful than CCs, these findings should be interpreted with caution, given that in half of the samples (50%), there was insufficient information to ascertain whether a majority of respondents held a particular RRP. Sampling strategy had an effect on the results, whereby in a large minority of probability-based samples (40%), a majority of respondents perceived NRT and CCs as equally harmful, while in almost one-half (47%) of non-probability-based samples, a majority of respondents perceived NRT as less harmful than CCs. In addition, a large proportion of both probability-based (60%) and non-probability-based (47%) samples did not report on the full spectrum of RRP, limiting this analysis. Although the findings should be interpreted with caution given this limitation, overall, in a large minority of samples, respondents correctly perceived the relative harmfulness of NRT and CCs.

#### SLT versus NRT

Perceptions of relative risk of SLT compared to NRT were examined in two samples from a nationally representative survey

**Table 1** Relative risk perceptions held by a majority of respondents, overall and for key subpopulations

Product comparison	Samples*	Proportion of samples in which a majority of respondents held a particular perception of relative risk (%)							
		Less	Less or equal	Equal	Equal or greater	Greater	Don't know†	None‡	Unknown§
SLT vs CCs (ref)	Overall (n=77)	<b>18</b>	3	13	6	0	0	27	32
	General population (n=20)	<b>20</b>	0	20	15	0	0	30	15
	Smokers (n=38)	<b>13</b>	0	11	5	0	0	16	55
	SLT users (n=13)	<b>38</b>	8	15	0	0	0	31	8
	SLT non-users (n=6)	<b>0</b>	17	0	0	0	0	83	0
ECs vs CCs (ref)	Overall (n=46)	<b>70</b>	0	0	0	0	4	17	9
	General population (n=11)	<b>64</b>	0	0	0	0	0	27	9
	Smokers (n=16)	<b>81</b>	0	0	0	0	0	19	0
	Non-smokers (n=2)	<b>0</b>	0	0	0	0	50	0	50
	EC users (n=16)	<b>75</b>	0	0	0	0	0	19	6
NRT vs CCs (ref)	Overall (n=20)¶	<b>35</b>	0	10	5	0	0	0	50
	General population (n=4)	<b>75</b>	0	0	25	0	0	0	0
	Smokers (n=12)	<b>25</b>	0	17	0	0	0	0	58
	NRT users (n=2)¶	<b>50</b>	0	0	0	0	0	0	50
	NRT non-users (n=2)¶	<b>0</b>	0	0	0	0	0	0	100
SLT vs NRT (ref)	Overall (n=2)¶	0	0	0	0	0	100	0	0
ECs vs NRT (ref)	Overall (n=1)¶	0	0	0	0	0	0	100	0

Bold results indicate the proportion of samples in which a majority of respondents held the epidemiologically correct perception of relative risk, for each product comparison.

\*Sample sizes reflect those extracted from observational studies for which quantitative comparable findings were reported. Samples from the following studies were excluded due to their experimental nature: SLT versus CCs.<sup>39-43</sup> Samples from the following studies were excluded due to use of an incompatible measure: SLT versus CCs;<sup>45</sup> ECs versus CCs;<sup>69-73</sup> ECs versus NRT.<sup>69</sup>

†Denotes samples in which a majority of respondents reported not knowing the relative risk of given products.

‡Denotes samples in which a particular perception of relative risk was not held by a majority of respondents.

§Denotes samples for which insufficient information was given to discern whether a majority of respondents held a particular perception of relative risk.

¶Denotes findings which should be interpreted with caution, given limitations with available data.

conducted in the USA by Regan *et al.*<sup>49</sup> In both study samples, a majority of respondents indicated that they did not know the relative harmfulness of these products.

### ECs versus NRT

Risk perceptions of ECs relative to NRT were examined in two samples from two studies.<sup>60-69</sup> In a probability-based sample of smokers in Great Britain,<sup>60</sup> RRP were highly variable, with no clear majority emerging. In addition, Harrell and colleagues reported that respondents in their study incorrectly perceived ECs as less harmful than NRT.<sup>69</sup>

### RRPs among key subpopulations

As shown in [table 1](#), in general, users of non-combustible nicotine products more often held accurate RRP than did non-users when comparing the harmfulness of their products to CCs. This pattern held for comparisons of each of SLT, ECs and NRT versus CCs: whereas a majority of respondents held accurate RRP in 38%, 75% and 50% of samples of users of the respective non-combustible nicotine products, in no samples of non-users did a majority share this view. In addition, cigarette smokers more often held epidemiologically correct RRP than did samples of the general population when comparing ECs with CCs (81% and 64%, respectively), and were almost on par when comparing SLT with CCs (13% and 18%, respectively). However, smokers fared worse than the general population when asked to compare the relative harmfulness of NRT and CCs: whereas a majority of respondents in 75% of samples drawn from the general population perceived NRT as less harmful than CCs, adult smokers greatly overestimated the relative risks of NRT, with a majority of respondents in just 25% of samples sharing this view.

### Amenability of RRP to change

Although limited, evidence from longitudinal and experimental studies indicates that RRP can change over time or under certain conditions,<sup>32-46</sup> highlighting their potential to serve as targets for health interventions. For instance, Borland *et al.*<sup>46</sup> showed that an educational fact sheet could lower false relative health beliefs among smokers, potentially encouraging them to switch to products that carry less risk. Furthermore, Callery *et al.*<sup>43</sup> demonstrated the plasticity of RRP under various conditions involving a health warning label (text or pictorial) and a relative health-risk message ('Using smokeless tobacco is less harmful than smoking cigarettes'). The findings showed that pictorial health warning labels increased false health beliefs about SLT compared to CCs, whereas text warning labels did not. In addition, the relative health-risk message decreased false health beliefs about the relative harmfulness of SLT, indicating the potential use of such messages in communicating relative health-risk information.

### Measures of RRP

#### Question structure and mechanics

A total of 57 measures were used to examine RRP across 54 studies.<sup>i</sup> As shown in [table 2](#), measures of RRP were highly variable and exhibited many characteristics. Although a majority of measures (n=41) operationalised risk as an overall concept of harm,<sup>22 and 23 24A 24B 27-30 31b 32 35 37 39 40 42a 43-46 50 51a 51b 52 54 57-63 65-73 75-76</sup> some were based on distinct dimensions

<sup>i</sup>Three studies<sup>31 42 51</sup> each used two distinct measures, which are referred to as "a" and "b", respectively, for each study (see Supplementary table S2).

**Table 2** Relative risk perception question structure and mechanics

	Number of measures	Sample measure	
		Question stem	Response options
<i>Question risk operationalisation</i>			
Overall harm	41	Please rate your level of agreement with the following statement: using e-cigarettes is less harmful to the health of the user than smoking cigarettes.	5-point Likert scale: <i>strongly agree to strongly disagree</i>
Perceived severity	4	Compare the health risks for a group of daily smokers with a group of daily users of snus. The smokers and snus users belong to the same age group, and have used tobacco for the same length of time. The risk for (cancer of the oral cavity/lung cancer/stomach cancer/cardiovascular disease) is ...	... far higher for snus users, somewhat higher for snus users, more or less equal for snus users and smokers, somewhat higher for smokers, or far higher for smokers
Perceived susceptibility	15	If a smoker switched from cigarettes to chewing tobacco/snuff, how much would they reduce their health risks associated with using tobacco products?	5-point Likert scale: <i>no reduction in risk to they would no longer be at risk</i>
Perceived likelihood	1	Are nicotine patches ... to cause someone to have a heart attack as cigarettes?	... more likely, about as likely, or less likely ...
<i>Question presentation</i>			
Presentation via survey's mode of administration	46	–	–
Inclusion of awareness prompt	9	Are you aware of any smokeless tobacco products, such as snuff or chewing tobacco, which are not burned or smoked but instead are usually put in the mouth?	No/Yes
Use of visual aid	2	Image of a pouch of snus	–
<i>Question mechanics</i>			
Direct	50	Please indicate your level of agreement with the following statement: e-cigarettes are safer to use than tobacco cigarettes.	5-point scale: <i>strongly disagree to strongly agree</i>
Indirect	7	a) In your opinion, how harmful are new smokeless tobacco products, such as snus, to general health? b) In your opinion, how harmful is smoking cigarettes for health?	7-point scale: <i>not at all harmful (1) to extremely harmful (7)</i> Differences between means for a) and b) were examined using t-tests
<i>Question stem (among direct measures, n=50)</i>			
Open	36	Do you think e-cigarettes are ... than regular cigarettes to health?	... more harmful, equally harmful, or less harmful ...
Closed	14	Please indicate your level of agreement with the following statement: smokeless tobacco is less harmful than cigarettes.	5-point Likert scale: <i>strongly agree to strongly disagree</i>
<i>Response options (among direct measures, n=50)</i>			
Continuous	36	Do you think e-cigarettes are harmful?	5-point Likert scale ranging from <i>strongly agree to strongly disagree</i>
Categorical	9	Do you think e-cigarettes are harmful?	No/Yes
Mixed	5	Do you think e-cigarettes are harmful?	Yes, they are more harmful than tobacco cigarettes / Yes, they are as harmful as tobacco cigarettes / Yes, but they are less harmful than tobacco cigarettes ; No, they are absolutely not harmful
<i>Response option tasks (among direct continuous measures, n=36)</i>			
Rating task	35	Compared to cigarettes, do you think that SLT is ... to a person's health?	... a lot less harmful, a little less harmful, about the same, a little more harmful, or a lot more harmful ...
Ranking task	1	Please rank the following items in terms of health risks (use 1, 2, 3, and 4). Use '1' for the item that is the most harmful and use '4' for the item that is least harmful: chewing tobacco or dip; cigarettes; cigars; hookah.	Use 1, 2, 3 and 4

of risk,<sup>77</sup> such as perceived severity,<sup>20 and 21 41 55 64</sup> perceived susceptibility,<sup>29 31a 33–34 36 38 42b 47–49 53 55–56 64 74</sup> and perceived likelihood.<sup>20 and 21</sup> In addition, several used aids to help guide respondents, such as an awareness prompt (n=9),<sup>22 and 23 30 24A 24B 49 50 54 56 58</sup> or visual aids, such as product images (n=2).<sup>24A 51</sup>

A majority of measures were direct in nature (n=50),<sup>20 and 21, 22 and 23 24A 24B 28–30 31a 31b 32–33 35 37–40 42a 42b 43–50 51a 52–63 65–68 70–76</sup> requiring respondents to make a direct comparison of the products, whereas seven measures were indirect,<sup>27 34 36 41 51b 64 69</sup> in which the responses to

separate questions were compared. Among the direct measures (n=50), question stems were either open (n=36),<sup>20 and 21, 22 and 23 24A 24B 28–30 31a 32–33 35 39–40 43–49 51a 52–61 63 65 67 71 72</sup> or closed (n=14).<sup>31b 37–38 42a 42b 50 62 66 68 70 73–76</sup> Among the direct measures (n=50), 36 were continuous,<sup>20 and 21, 22 and 23 24A 24B 29 31a 31b 33 37 39–40 43–45 47–50 51a 52 54–56 58–60 62 63 65 66 71–76</sup> 9 were categorical,<sup>28 30 32 35 38 42a 42b 68 70</sup> and 5 were mixed.<sup>46 53 57 61 67</sup> Of the continuous measures (n=36), a majority involved a rating task (n=35),<sup>20 and 21, 22 and 23 24A 24B 29 31a 31b 37 39–40 43–45 47–50 51a 52 54–56 58–60 62 63 65 66 71–76</sup> while 1 involved a ranking task.<sup>33</sup>

### Effect of direct versus indirect measures on RRP

Figure 2A illustrates the proportion of respondents who correctly perceived SLT to be less harmful than CCs for studies using direct and indirect measures. The proportion of respondents who correctly perceived SLT to be less harmful than CCs ranged from 2% to 93% for direct measures, and from 41% to 59% for indirect measures. A study by Popova and Ling<sup>51</sup> applied both a direct measure and an indirect measure within a representative sample of US smokers to assess RRP of snus versus CCs. As depicted in figure 2B, using the direct measure, 22% of respondents reported that snus was less harmful than CCs, and the overall mean comparative harmfulness of snus was 0.02 (SD=1.16), which was not significantly different from 0 ( $t(1791)=0.691$ ;  $p=0.5$ ); however, using the indirect measure, 52% of respondents rated snus as less harmful than CCs, and the mean harmfulness of CCs and snus was 5.91 (SD=1.23) and 4.97 (SD=1.55), respectively, with a mean difference of 0.94 (SD=1.68), which was significantly different from 0 ( $t(1788)=23.690$ ;  $p<0.001$ ). Although the direct and indirect measures were correlated ( $r=0.31$  ( $p<0.001$ )),<sup>51</sup> the findings demonstrate that measurement methods can influence estimates of RRP. Indeed, the parallel results found in the current review appear to further support this finding.

### CONCLUSIONS

The results of this review indicate that accurate perceptions about the basic risk of nicotine products are rare. In most studies, respondents held variable, yet inaccurate, RRP when comparing SLT to CCs, and ECs to NRT. In addition, in most studies, respondents did not know the relative harmfulness of SLT versus NRT. The findings relating to comparisons of ECs versus NRT and of SLT versus NRT should be interpreted with caution, given the limited number of samples examined. In contrast, in many studies, respondents correctly perceived NRT as less harmful than CCs, although these findings also require caution, given data limitations. Finally, the exception to this general pattern lies with the comparison of ECs and CCs, in which respondents in most studies correctly perceived ECs as the less harmful product.

The variability of RRP across product comparisons is not surprising. First, not all individuals may be familiar with specific products. Second, individuals may lack the knowledge about these products' health effects needed to judge their relative harmfulness. Indeed, research indicates that although some members of the public understand that smoking is 'bad for you', most cannot identify its health consequences.<sup>78</sup> Third, individuals may have been misled by public health authorities, which have provided misinformation on the risks of SLT relative to CCs in the USA, where most of the reviewed population surveys were conducted.<sup>17 18</sup> Evidence from qualitative research may help reveal the reasons underlying RRP.<sup>79 80</sup>

Perceptions of relative risk also varied among key subpopulations, with smokers and users of non-combustible nicotine products more likely to correctly perceive the relative harmfulness of products compared to non-users. Although this finding may be explained by theories of selective exposure and perception,<sup>81</sup> according to which users' perceptions are coloured by their experiences of product use,<sup>42</sup> the cross-sectional nature of most of the reviewed studies precludes an examination of the temporal relationship between user perceptions and behaviour. The finding that smokers more often held epidemiologically correct RRP than did samples of the general population when comparing ECs with CCs may be due to targeted EC marketing

strategies,<sup>3</sup> and greater personal relevance of such information to smokers.<sup>71</sup> However, smokers fared worse than the general population when asked to compare the relative harmfulness of NRT and CCs, with most smokers greatly overestimating the harmfulness of NRT. This finding may reflect an attempt to bolster positive perceptions of CCs as a means to alleviate cognitive dissonance,<sup>82</sup> potentially extending the defensive behaviour exhibited by smokers with respect to justifications for their smoking to product perceptions.<sup>83</sup> Alternatively, this may reflect the common misperception held by smokers that nicotine is the most harmful constituent of tobacco.<sup>20 21</sup> Similarly, users of non-combustible nicotine products fared well with respect to the accuracy of their RRP. This pattern held consistently for comparisons of each of SLT, ECs and NRT to CCs, which may reflect the formation of positive preferences for users' own products, which carry less risk.<sup>81</sup>

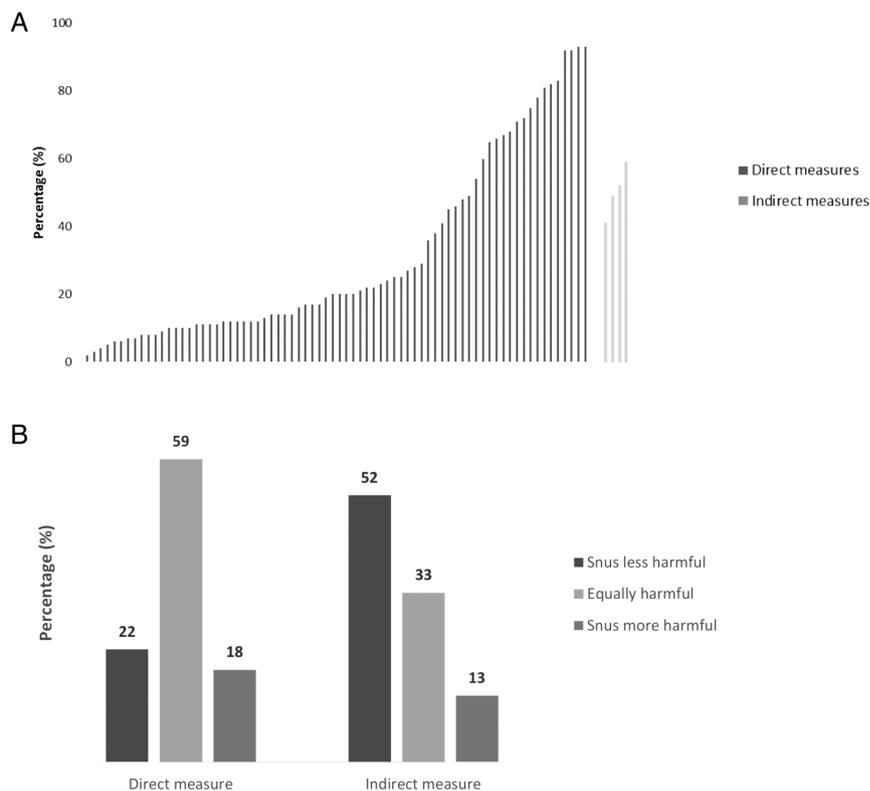
Comparisons of ECs and CCs are noteworthy, given that this was the only product comparison for which most respondents held RRP that coincided with epidemiological data. This may be due to the rapid growth of the EC market, in which the public has been greatly exposed to the 'disruptive innovation' of ECs through the media.<sup>84 85</sup> In addition, the fact that ECs do not contain tobacco distinguishes them from tobacco products, which may lend itself to more accurate RRP. Furthermore, from the perspective of smokers, the greater appeal of ECs may give these products an advantage in overall receptivity over NRT.<sup>62 86</sup> These distinct findings suggest that policymakers take particular note of these novel products and monitor them closely.

Evidence from longitudinal and experimental studies demonstrated the amenability of RRP to change, highlighting their potential to serve as targets for health interventions and in health risk communication. Given the paucity of available evidence, researchers should consider employing intervention and experimental designs to further test the plasticity and potential use of RRP in promoting health behaviour change. Borland *et al*<sup>46</sup> and Callery *et al*<sup>43</sup> suggest examining various types of educational interventions over time, such as product package inserts and point-of-sale displays. Irrespective of the communication mode, factors such as the length, relevance, readability and interpretation of the presented information by consumers, and any potential effects these may have on behaviour should also be examined.<sup>51</sup> For instance, the delivery of relative risk information for NRT in a manner that is compelling to smokers may help correct their misperceptions, thereby assisting in cessation efforts.

### Implications for policymakers

The findings of this review present several challenges for tobacco control policymakers. First, the high degree of contextual variability highlights the challenges of measuring RRP across the nicotine spectrum. Although the FDA aims to assess RRP among the public, particularly with respect to the introduction and postmarket surveillance of modified risk tobacco products,<sup>19</sup> a 'one size fits all' approach seems unlikely to work. Second, the extent of inaccurate health beliefs regarding these products implies that significant efforts will be required to bring the public's knowledge in line with objective evidence. For instance, although Swedish Match received approval for the sale of its snus products in the USA,<sup>87</sup> an advisory panel to the FDA did not approve the company's request for a reduced harm claim, in part because the company had not adequately tested whether consumers would understand or correctly interpret the proposed claim.<sup>88</sup> Irrespective of the anticipated difficulty involved in constructing relative health-risk messages, public

**Figure 2** Comparison of relative risk perceptions of SLT versus CCs using direct and indirect measures in the current review (A) and in Popova & Ling (B).<sup>51</sup> (A) Proportion of respondents by study sample who perceived SLT as less harmful than CCs using direct measures ( $n_{\text{SAMPLE}}=74$ ;  $n_{\text{STUDY}}=25$ )\* and indirect measures ( $n_{\text{SAMPLE}}=4$ ;  $n_{\text{STUDY}}=4$ )\*. \*Samples included in this analysis were those for which quantitative comparable findings were reported. Samples from the following studies were excluded due to use of an incompatible direct measure,<sup>45</sup> and incompatible indirect measures.<sup>27 41</sup> (B) Proportion of respondents perceiving snus as less harmful, equally harmful or more harmful than CCs in Popova and Ling.<sup>51</sup> CCs, combustible cigarettes; SLT, smokeless tobacco.



**Note: Direct measure:** "Compared to smoking cigarettes, using new smokeless tobacco, such as snus, is ..." with responses on a 7-point scale ranging from -3=a lot less harmful; to 0=equally as harmful; to +3=a lot more harmful.

**Indirect measure:** Two separate questions were asked: "In your opinion, how harmful are new smokeless tobacco products, such as snus, to general health?" and "In your opinion, how harmful is smoking cigarettes for health?" The answers to both were on 7-point scales, ranging from 1=not at all harmful, to 7=extremely harmful.

**Note:** Percentages for direct and indirect measures do not add to 100% because of missing data (direct 0.9%; indirect 2.6%).

health authorities must attempt to address this need. In the absence of evidence-based health-risk communication from such authorities, the public's reliance on industry-sponsored marketing, media and anecdotal evidence,<sup>1</sup> is likely to increase. Next, in addition to developing appropriate content, authorities need to ensure that the communication of health-risk information is designed and executed to maximise consumer understanding. Furthermore, policymakers should consider the appropriate threshold of prevalence of inaccurate health beliefs that would require regulatory action. Although a majority (>50%) threshold was used to describe RRP in the current analysis, it is not clear whether this should be applied to the policy domain. For instance, from a population perspective, addressing inaccurate risk perceptions even at the level of 10% can be critically important, considering that in countries such as the USA, this amounts to many millions of individuals.<sup>89</sup>

### Recommendations for researchers

Despite the challenges of measuring subjective RRP, several practices can improve research methods. For instance, visual aids may improve the specificity of relative risk tasks, particularly for novel products. Next, it is not always clear what respondents mean when they indicate that a product is 'less harmful' than another.<sup>30</sup> To reduce this ambiguity, researchers should construct their measures so as to suit their study population. For instance, questions that embody distinctions between product dose, duration and mode of use tend to be better suited to populations of product users.<sup>90</sup> Overall, measures should be tested to ensure that they are familiar and relevant to, as well as understood by, study respondents.<sup>90</sup>

Several technical dimensions of measures of risk should be noted. First, RRP measures should use response options with verbal qualitative comparisons (eg, ranging from 'no risk' to 'great risk'), rather than numerical scales (eg, ranging from 0% to 100%), given the difficulty lay people experience in understanding and using numerical estimates of risk.<sup>78</sup> Second, indirect measures may help reduce social desirability bias, particularly in contexts where the 'no safe tobacco product' message resounds. Third, research regarding the validity of direct and indirect measures is also warranted. Fourth, measures should be constructed with open question stems, for example, 'Do you think e-cigarettes are ... *more harmful/equally harmful/less harmful* ... than regular cigarettes to health?', as these allow researchers to clearly delineate all potential RRP. In contrast, measures employing closed question stems, for example, 'Please indicate your level of agreement with the following statement: SLT is less harmful than cigarettes. 5-point Likert scale: *strongly agree* to *strongly disagree*', result in ambiguities, as researchers are unable to ascertain what respondents perceive when they indicate that they disagree with a proposed statement. Furthermore, such measures may be more susceptible to acquiescence bias. Fifth, measures with continuous (rather than categorical) response options are likely to reflect RRP more appropriately, given that these attitudinal constructs lend themselves to measurement along a scale.<sup>25</sup> Next, both rating and ranking tasks can be employed to measure RRP: while rating tasks focus attention on one or two products, ranking tasks encourage participants to consider the full product spectrum, while also reducing social desirability bias.<sup>25</sup> Finally, although researchers may be interested in a particular RRP between products, it is recommended that they measure and report on the full range of RRP so that these may be available in

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the literature. By reducing the ambiguity of findings, such practices will improve the understanding of RRP as well as the capacity to intervene and correct misperceptions.

### Strengths and limitations of this review

To the best of our knowledge this review is the first to summarise empirical data on perceptions of relative risk across the non-combustible nicotine spectrum, although it has several limitations. First, given the heterogeneity of studies with respect to quality, populations, policy contexts and measures included in this review, readers should interpret the findings with care: although the findings provide a summary of RRP across products, additional research is needed to examine these factors' influence in greater detail. In addition, due to the fact that the descriptive analyses conducted here depend in part on the epidemiological evidence base of the risks of non-combustible nicotine products, the findings are relative to this evidence base and the product market at this point in time, and may change as these elements evolve.

In summary, perceptions of relative risk of non-combustible nicotine products are highly variable and specific to particular products and subpopulations. Overall, in most studies, respondents' RRP of non-combustible nicotine products do not accurately reflect the products' underlying objective differences in risk, presenting several challenges for policymakers. In addition, researchers ought to be aware of the differences in question mechanics and the effects these may have on the findings in order to ensure accurate monitoring. The central role played by perceptions of relative risk in health behaviour implies that the challenges surrounding the measurement, communication and intervention on these perceptions must be met in order to shift tobacco users away from the deadliest nicotine-delivery device to less harmful forms, in addition to assisting cessation efforts. Public health policy that addresses these challenges will better reflect the complexity of the nicotine market and better address the substantial risks of combusted tobacco.

### What this paper adds

Consumer perceptions of relative risk of non-combustible nicotine products play an important role in influencing how existing and emerging products are used and by whom. This systematic review found that:

- ▶ Perceptions of relative risk of non-combustible nicotine products are highly variable and specific to particular products and subpopulations;
- ▶ Accurate perceptions of the relative risks of non-combustible nicotine products are rare, although respondents in most studies correctly perceived e-cigarettes as less harmful than cigarettes;
- ▶ Cigarette smokers and users of non-combustible nicotine products tend to correctly perceive the relative harmfulness of products more often than non-users.

Researchers and policymakers must address the challenges of measuring and communicating relative health risk information across the nicotine spectrum in order to better reflect the complexity of the current nicotine market and better address the substantial risks of combusted tobacco.

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### REFERENCES

- 1 Zeller M, Hatsukami D, the Strategic Dialogue on Tobacco Harm Reduction Group. The Strategic Dialogue on Tobacco Harm Reduction: a vision and blueprint for action in the US. *Tob Control* 2009;18:324–32.
- 2 Hatsukami DK, Ebbert JO, Feuer RM, et al. Changing smokeless tobacco products. New tobacco-delivery systems. *Am J Prev Med* 2007;33:S368–78.
- 3 National Cancer Institute & Centers for Disease Control and Prevention. *Smokeless tobacco and public health: a global perspective* 2014. <http://nccd.cdc.gov/gtssdata/Ancillary/Publications.aspx> (accessed Jul 2015).
- 4 Levy DT, Mumford EA, Cummings KM, et al. The relative risks of a low-nitrosamine smokeless tobacco product compared with smoking cigarettes: estimates of a panel of experts. *Cancer Epidemiol Biomarkers Prev* 2004;13:2035–42.
- 5 Breland A, Soule E, Lopez A, et al. Electronic cigarettes: what are they and what do they do? *Ann N Y Acad Sci* Published Online First: 15 Jan 2016. doi:10.1111/nyas.12977
- 6 Hajek P, Etter J-F, Benowitz N, et al. Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit. *Addiction* 2014;109:1801–10.
- 7 Grana R, Benowitz N, Glantz SA. E-cigarettes: a scientific review. *Circulation* 2014;129:1972–86.
- 8 Stratton K, Shetty P, Wallace R, et al. Clearing the smoke: the science base for tobacco harm reduction—executive summary. *Tob Control* 2001;10:189–95.
- 9 Benowitz NL, Goniewicz ML. The regulatory challenge of electronic cigarettes. *JAMA* 2013;310:685–6.
- 10 Romer D, Jamieson P. The role of perceived risk in starting and stopping smoking. In: Slovic P, ed. *Smoking, Risk, perception, & policy*. Thousand Oaks, CA: Sage Publications, Inc, 2001:64–80.
- 11 Hyland A, Li Q, Bauer JE, et al. Predictors of cessation in a cohort of current and former smokers followed over 13 years. *Nicotine Tob Res* 2004;6:S363–9.
- 12 Costello MJ, Logel C, Fong GT, et al. Perceived risk and quitting behaviors: results from the ITC 4-country survey. *Am J Health Behav* 2012;36:681–92.
- 13 Cengelli S, O'Loughlin J, Lauzon B, et al. A systematic review of longitudinal population-based studies on the predictors of smoking cessation in adolescent and youth adult smokers. *Tob Control* 2012;21:355–62.
- 14 Arens CR, White TL, Massengill N. Attitudinal factors protective against youth smoking: an integrative review. *J Nurs Scholarsh* 2014;46:167–75.
- 15 Kozlowski LT, Edwards BQ. "Not safe" is not enough: smokers have a right to know more than there is no safe tobacco product. *Tob Control* 2005;14:i3–7.
- 16 Phillips CV, Wang C, Guenzel B. You might as well smoke; the misleading and harmful public message about smokeless tobacco. *BMC Public Health* 2005;5:31.
- 17 Kozlowski LT, O'Connor RJ. Apply federal research rules on deception to misleading health information: an example on smokeless tobacco and cigarettes. *Public Health Rep* 2003;118:187–92.
- 18 Kozlowski LT, Sweanor D. Withholding differential risk information on legal consumer nicotine/tobacco products: the public health ethics of health information quarantines. *Int J Drug Policy* 2016;32:17–23.
- 19 111<sup>th</sup> Congress. *Family Smoking Prevention and Tobacco Control Act* 2009. <http://www.gpo.gov/fdsys/pkg/PLAW-111publ31/pdf/PLAW-111publ31.pdf> (accessed Jul 2015).
- 20 Bansal MA, Cummings KM, Hyland A, et al. Stop-smoking medications: who uses them, who misuses them, and who is misinformed about them? *Nicotine Tob Res* 2004;6:S303–10.
- 21 Cummings KM, Hyland A, Giovino GA, et al. Are smokers adequately informed about the health risks of smoking and medicinal nicotine? *Nicotine Tob Res* 2004;6:S333–40.
- 22 Ambrose BK, Rostron BL, Johnson SE, et al. Perceptions of the relative harm of cigarettes and e-cigarettes among US youth. *Am J Prev Med* 2014;47:S53–60.
- 23 Amrock SM, Zakhar J, Zhou S, et al. Perception of e-cigarettes' harm and its correlation with use among U.S. adolescents. *Nicotine Tob Res* 2014;17:330–6.

- 24 Pearson JL, Richardson A, Niaura RS, *et al.* E-cigarette awareness, use, and harm perceptions in US adults. *Am J Public Health* 2012;102:1758–66.
- 25 Streiner DL, Norman GR. *Health measurement scales: a practical guide to their development and use*. New York, USA: Oxford University Press, 2008.
- 26 Grimshaw J. *A knowledge synthesis chapter* 2010. <http://www.cchr-irsc.gc.ca/e/41382.html> (accessed Jun 2015).
- 27 Schaefer SD, Henderson AH, Glover ED, *et al.* Patterns of use and incidence of smokeless tobacco consumption in school-age children. *JAMA Otolaryngol Head Neck Surg* 1985;111:639–42.
- 28 Prokhorov AV, Wetter DW, Padgett D, *et al.* Spit tobacco prevention and cessation counseling: statewide survey of health-care professionals and educators. *Substance Use Misuse* 2002;37:171–97.
- 29 Haddock CK, Lando H, Klesges RC, *et al.* Modified tobacco use and lifestyle change in risk-reducing beliefs about smoking. *Am J Prev Med* 2004;27:35–41.
- 30 O'Connor RJ, Hyland A, Giovino GA, *et al.* Smoker awareness of and beliefs about supposedly less-harmful tobacco products. *Am J Prev Med* 2005;29:85–90.
- 31 Klesges RC, Klesges LM, Vander Weg MW, *et al.* Characteristics of air force personnel who choose pharmacological aids for smoking cessation following an involuntary tobacco ban and tobacco control program. *Health Psychol* 2007;26:588–97.
- 32 O'Connor RJ, McNeill A, Borland R, *et al.* Smokers' beliefs about the relative safety of other tobacco products: findings from the ITC collaboration. *Nicotine Tob Res* 2007;9:1033–42.
- 33 Smith SY, Curbow B, Stillman FA. Harm perception of nicotine products in college freshmen. *Nicotine Tob Res* 2007;9:977–82.
- 34 Tomar SL, Hatsukami DK. Perceived risk of harm from cigarettes or smokeless tobacco among U.S. high school seniors. *Nicotine Tob Res* 2007;9:1191–6.
- 35 Kaduri P, Kitua H, Mbatia J, *et al.* Smokeless tobacco use among adolescents in Ilala municipality, Tanzania. *Tanzan J Health Res* 2008;10:28–33.
- 36 Overland S, Hetland J, Aaro LE. Relative harm of snus and cigarettes: what do Norwegian adolescents say? *Tob Control* 2008;17:422–5.
- 37 Biener L, Bogen K. Receptivity to Taboka and Camel snus in a U.S. test market. *Nicotine Tob Res* 2009;11:1154–9.
- 38 Timberlake DS. Are smokers receptive to using smokeless tobacco as a substitute? *Prev Med* 2009;49:229–32.
- 39 Carpenter MJ, Gray KM. A pilot randomized study of smokeless tobacco use among smokers not interested in quitting: changes in smoking behavior and readiness to quit. *Nicotine Tob Res* 2010;12:136–43.
- 40 Gartner CE, Jimenez-Soto EV, Borland R, *et al.* Are Australian smokers interested in using low-nitrosamine smokeless tobacco for harm reduction? *Tob Control* 2010;19:451–6.
- 41 Peiper N, Stone R, Van Zyl R, *et al.* University faculty perceptions of the health risks related to cigarettes and smokeless tobacco. *Drug Alcohol Rev* 2010;29:121–30.
- 42 Wikmans T, Ramstrom L. Harm perception among Swedish daily smokers regarding nicotine, NRT-products and Swedish snus. *Tob Induc Dis* 2010;8:9.
- 43 Callery WE, Hammond D, O'Connor RJ, *et al.* The appeal of smokeless tobacco products among young Canadian smokers: the impact of pictorial health warnings and relative risk messages. *Nicotine Tob Res* 2011;13:373–83.
- 44 McClave-Regan AK, Berkowitz J. Smokers who are also using smokeless tobacco products in the US: a national assessment of characteristics, behaviours and beliefs of 'dual users'. *Tob Control* 2011;20:239–42.
- 45 Smith JR, Novotny TE, Edland SD, *et al.* Determinants of hookah use among high school students. *Nicotine Tob Res* 2011;13:565–72.
- 46 Borland R, Li L, Cummings KM, *et al.* Effects of a fact sheet on beliefs about the harmfulness of alternative nicotine delivery systems compared with cigarettes. *Harm Reduct J* 2012;9:19.
- 47 Lund I, Scheffels J. Perceptions of the relative harmfulness of snus among Norwegian general practitioners and their effect on the tendency to recommend snus in smoking cessation. *Nicotine Tob Res* 2012;14:169–75.
- 48 Lund KE. Association between willingness to use snus to quit smoking and perception of relative risk between snus and cigarettes. *Nicotine Tob Res* 2012;14:1221–8.
- 49 Regan AK, Dube SR, Aranzola R. Smokeless and flavored tobacco products in the US: 2009 Styles Survey results. *Am J Prev Med* 2012;42:29–36.
- 50 Choi K, Forster J. Characteristics associated with awareness, perceptions, and use of electronic nicotine delivery systems among young US Midwestern adults. *Am J Public Health* 2013;103:556–61.
- 51 Popova L, Ling PM. Perceptions of relative risk of snus and cigarettes among US smokers. *Am J Public Health* 2013;103:e21–3.
- 52 Ayo-Yusuf OA, Agaku IT. Intention to switch to smokeless tobacco use among South African smokers: results from the 2007 South African Social Attitudes Survey. *PLOS ONE* 2014;9:e95553.
- 53 England LJ, Anderson BL, Tong VTK, *et al.* Screening practices and attitudes of obstetricians-gynecologists toward new and emerging tobacco products. *Am J Obstet Gynecol* 2014;211:e1–7.
- 54 Kaufman AR, Mays D, Koblitz AR, *et al.* Judgments, awareness, and the use of snus among adults in the United States. *Nicotine Tob Res* 2014;16:1404–8.
- 55 Lund I, Scheffels J. Perceptions of relative risk of disease and addiction from cigarettes and snus. *Psychol Addict Behav* 2014;28:367–75.
- 56 Richardson A, Pearson J, Xiao H, *et al.* Prevalence, harm perceptions, and reasons for using noncombustible tobacco products among current and former smokers. *Am J Public Health* 2014;104:1437–44.
- 57 Goniewicz ML, Zielinska-Danch W. Electronic cigarette use among teenagers and young adults in Poland. *Pediatrics* 2012;130:e879–85.
- 58 Adkison SE, O'Connor RJ, Bansal-Travers M, *et al.* Electronic nicotine delivery systems: International Tobacco Control Four-Country Survey. *Am J Prev Med* 2013;44:207–15.
- 59 Dawkins L, Turner J, Roberts A, *et al.* 'Vaping' profiles and preferences: an online survey of electronic cigarette users. *Addiction* 2013;108:1115–25.
- 60 Dockrell M, Morrison R, Bauld L, *et al.* E-cigarettes: prevalence and attitudes in Great Britain. *Nicotine Tob Res* 2013;15:1737–44.
- 61 Goniewicz ML, Lingas EO, Hajek P. Patterns of electronic cigarette use and user beliefs about their safety and benefits: an internet survey. *Drug Alcohol Rev* 2013;32:133–40.
- 62 Li J, Bullen C, Newcombe R, *et al.* The use and acceptability of electronic cigarettes among New Zealand smokers. *N Z Med J* 2013;126:48–57.
- 63 Sutfin EL, McCoy TP, Morrell HER, *et al.* Electronic cigarette use by college students. *Drug Alcohol Depend* 2013;131:214–21.
- 64 Baeza-Loya S, Viswanath H, Carter A, *et al.* Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. *Bull Meninger Clin* 2014;78:243–52.
- 65 Brown J, West R, Beard E, *et al.* Prevalence and characteristics of e-cigarette users in Great Britain: findings from a general population survey of smokers. *Addict Behav* 2014;39:1120–5.
- 66 Choi K, Forster JL. Beliefs and experimentation with electronic cigarettes: a prospective analysis among young adults. *Am J Prev Med* 2014;46:175–8.
- 67 Farsalinos KE, Romagna G, Tsiapras D, *et al.* Characteristics, perceived side effects and benefits of electronic cigarette use: a worldwide survey of more than 19,000 consumers. *Int J Environ Res Public Health* 2014;11:4356–73.
- 68 Gallus S, Lugo A, Pacifici R, *et al.* E-cigarette awareness, use, and harm perceptions in Italy: a national representative survey. *Nicotine Tob Res* 2014;16:1541–8.
- 69 Harrell PT, Marquez NS, Correa JB, *et al.* Expectancies for cigarettes, e-cigarettes, and nicotine replacement therapies among e-cigarette users ("vapers"). *Nicotine Tob Res* 2014;7:193–200.
- 70 Kandra KL, Ranney LM, Lee JGL, *et al.* Physicians' attitudes and use of e-cigarettes as cessation devices, North Carolina, 2013. *PLOS ONE* 2014;9:e103462.
- 71 Tan ASL, Bigman CA. E-cigarette awareness and perceived harmfulness: prevalence and associations with smoking-cessation outcomes. *Am J Prev Med* 2014;47:141–9.
- 72 Tucker JS, Shadel WG, Golinelli D, *et al.* Alternative tobacco product use and smoking cessation among homeless youth in Los Angeles county. *Nicotine Tob Res* 2014;16:1522–6.
- 73 Pokhrel P, Fagan P, Kehl L, *et al.* Receptivity to e-cigarette marketing, harm perceptions, and e-cigarette use. *Am J Health Behav* 2015;39:121–31.
- 74 Herbert R, Coleman T, Britton J. U.K. general practitioners' beliefs, attitudes, and reported prescribing of nicotine replacement therapy in pregnancy. *Nicotine Tob Res* 2005;7:541–6.
- 75 Shiffman S, Ferguson SG, Rohay J, *et al.* Perceived safety and efficacy of nicotine replacement therapies among US smokers and ex-smokers: relationship with use and compliance. *Addiction* 2008;103:1371–8.
- 76 Bobak A, Shiffman S, Gitchell JG, *et al.* Perceived safety of nicotine and the use of nicotine replacement products among current smokers in Great Britain: results from two national surveys. *J Smok Cessat* 2010;5:115–22.
- 77 Brewer NT, Chapman GB, Gibbons FX, *et al.* Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychol* 2007;26:136–45.
- 78 Weinstein ND. What does it mean to understand a risk—evaluating risk comprehension. *J Natl Cancer Inst Monographs* 1999;25:15–20.
- 79 Sami M, Timberlake DS, Nelson R, *et al.* Smokers' perceptions of smokeless tobacco and harm reduction. *J Public Health Policy* 2012;33:188–201.
- 80 Barbeau AM, Burda J, Siegel M. Perceived efficacy of e-cigarettes versus nicotine replacement therapy among successful e-cigarette users: a qualitative approach. *Addict Sci Clin Pract* 2013;8:5.
- 81 Klapper JT. *The effects of mass communication*. New York, USA: Free Press, 1960.
- 82 Festinger L. *A theory of cognitive dissonance*. Illinois: Row and Peterson, 1957.
- 83 Fotuhi O, Fong GT, Zanna MP, *et al.* Patterns of cognitive dissonance-reducing beliefs among smokers: a longitudinal analysis from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 2013;22:52–8.
- 84 Besaratinia A, Tommasi S. Electronic cigarettes: the road ahead. *Prev Med* 2014;66:65–7.
- 85 Yamin C, Bitton A, Bates DW. E-cigarettes: a rapidly growing internet phenomenon. *Ann Intern Med* 2010;153:607–9.
- 86 Steinberg MB, Zimmerman MH, Delnevo CD, *et al.* E-cigarette versus nicotine inhaler: comparing the perceptions and experiences of inhaled nicotine devices. *J Gen Intern Med* 2014;29:1444–50.

## Review

- 87 Clarke T. *FDA approves sale of eight new Swedish Match snus products*. Reuters, 2015. <http://www.reuters.com/article/us-swedish-match-tobacco-usa-idUSKCN0SZ2R420151110> (accessed Dec 2015).
- 88 Clarke T. *FDA panel votes against label change to Swedish Match snus*. Reuters, 2015. <http://www.reuters.com/article/us-swedish-match-fda-idUSKBN0N11VP20150410> (accessed Dec 2015).
- 89 U.S. Department of Health and Human Services. *The health consequences of smoking—50 years of progress. A report of the Surgeon General*. 2014. <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/> (accessed Jun 2015).
- 90 Karlsson P. *Between a rock and a whirlpool? Measurement problems in assessing risk perceptions of illicit drug use*. *J Stud Alcohol Drugs* 2011;28:149–57.

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## How do consumers perceive differences in risk across nicotine products? A review of relative risk perceptions across smokeless tobacco, e-cigarettes, nicotine replacement therapy and combustible cigarettes

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