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THE IMPACT OF FLAVORING ON TOBACCO/NICOTINE PRODUCT INITIATION AND ATTRACTIVENESS

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EXECUTIVE SUMMARY

Ramboll was asked and funded by Swedish Match to conduct a review of the literature on the relationship between flavorings used in tobacco and nicotine products and perceived "attractiveness" (or equivalent). The funders had no role in the study design, data collection, and analyses contained in this review.

Introduction

The FDA recently announced impending regulation of the availability of flavored tobacco products given their possible role in tobacco initiation and their attractiveness to youth. Studies on flavored tobacco products have increased in recent years with a considerable number of reviews already available. An overview of reviews is presented to consolidate information on flavoring agents used in tobacco products, particularly when related to youth initiation and preferences. Noting a lack of reviews on the efficacy of flavored tobacco bans, a systematic search and review of the evidence was conducted. Additionally, the systematic search revealed studies on discrete choice experiments assessing the role of flavor in product selection. As these studies have not been discussed in previous reviews, a synthesis of discrete choice experiment findings is also presented. These studies are reviewed to understand whether the availability of flavored tobacco products increase tobacco initiation, with a focus on differences by age. Lastly, the proportion of first-time users who used flavored tobacco products was calculated using data from the latest Population Assessment of Tobacco and Health Study (PATH).

Overview of Results from Systematic Reviews

The volume of published studies on the role of flavor in perception, initiation, and maintenance of tobacco use has increased in recent years. Nine reviews related to tobacco flavors have been published in the past four years. These studies have variety in their inclusionary criteria as some studies focus on only the US, others focus on qualitative data, others expand to include all e-cigarette attributes beyond flavorings, and others focus on non-menthol tobacco flavors. The available reviews analyzed data based on region, tobacco use and age, perceptions/attitudes towards flavors, and harm perceptions of flavors. The limitations that were most often discussed regarding the available body of evidence included a lack of longitudinal data, preference data for flavored smells, specificity in tobacco product type, and specificity in dual use status.

The wide availability in device types, tobacco products, flavor variation, and brands complicate synthesis of the evidence. However, the overall trends in the findings from a growing amount of focus groups, cross-sectional studies, and experimental evidence suggest that youth (and younger age groups) compared to adults have higher preference of flavors and higher use of flavored products. This trend is bolstered by the potential impact of flavoring on other variables previously associated with initiation. For example, flavor (and associated product descriptions) has shown effects on harm perception in youth, appeal of packaging, social acceptability, and novelty. Overall, the direct and indirect evidence would suggest flavors play a larger role in tobacco initiation for youths than in adults.

Impact of Flavor Bans

The enforcement of various policies banning the use of flavors in certain or all tobacco products present the opportunity to observe a natural experiment through interrupted time series analysis or

pre- and post- survey data. This type of study evaluates whether significant changes occurred in the level or trends of a variable of interest after a specific time point. We hypothesized that some researchers had evaluated the impact of these bans and noted that a previous review had called for evaluation of the impact of pre-existing regulations. No existing reviews or synthesis of regulatory impact of flavor bans on change in tobacco use or sales were available in the literature prior to this study.

Various local and national policies have been enacted in different jurisdictions throughout the world. In 2009, the U.S. FDA enacted a policy banning flavored (excluding menthol) cigarettes nationally. In 2010, New York City banned all tobacco flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, and roll-your-own tobacco, and dissolvable tobacco. In 2010, Canada banned all flavored (excluding menthol) cigarettes, cigarillos/little cigars, and blunt wraps. The repercussions of these bans on youth use and tobacco sales were evaluated.

The ecological nature of data prevented causal inference especially considering the lack of comparison areas in all youth use behavior studies and in only two sales-related studies. Nevertheless, the data on youth-use behavior provided supporting evidence for an association of flavor bans with declining use in youth and young adults and the sales data provides support for compliance, decreases in overall use, and possible tobacco product substitution.

Discrete Choice Experiments

Discrete choice experiments (DCEs) are an established marketing and microeconomic methodology that allows simultaneous testing of the influence of product characteristics. Respondents are given various sets of hypothetical situations in which they must choose between several alternatives. This methodology has been increasingly used in tobacco research in recent years (Regmi et al. 2017). DCEs allow comparison of the relative importance of different product attributes on the final decision to use a product. They also allow assessing interactions of product characteristics on selection of tobacco products. They have also been used to hypothesize the quantitative impact of alternative policies that are currently not in place (Buckell et al. 2018). DCEs are generally limited by measuring a stated preference rather than a substitute for actual behavior. However, other studies have shown comparability between experimental and real-world behaviors for tobacco (Few et al. 2012; Wilson et al. 2015). DCE tobacco studies have been reviewed previously (Regmi et al. 2017), but the previous review did not focus on DCEs on flavor preferences and lacked half of the studies included here. Five DCE studies were evaluated and synthesized.

This review of discrete choice experiment studies found two trends in the evidence: an increased selection of flavored tobacco products compared to non-flavored products by youth, and an increased selection by older adults of tobacco flavored products compared to younger adults. These studies generally pointed to important heterogeneity in selected products by age. However, results among young adults were more varied and difficult to interpret.

First-time Adult and Youth User's Selection of Flavored Products in PATH

The Population Assessment of Tobacco and Health (PATH) study is a longitudinal panel survey that plans to follow the same cohort of people. This section of the report used data from the recently released third wave of PATH. This section assessed what proportion of youth or adults tried flavored

products the first time they tried a tobacco product. Waves of the survey vary slightly in data for each tobacco product, but each wave includes information on snus and smokeless tobacco.

At each wave, a large proportion of youth identified consuming a flavored product their first time using any tobacco product. At least 60% of first-time users of smokeless tobacco selected flavored products in each wave. At least 70% of first-time users of snus pouches selected flavored products in each wave. The results suggest the majority of first-time youth users of snus and smokeless tobacco consumed flavored varieties.

At each wave, a majority of adult users identified consuming a flavored tobacco product their first time using any tobacco products. However, no waves report first-time users of smokeless tobacco selecting flavored products over half the time. At least 50% of first-time users of snus pouches selected flavored products in each wave.

Comparatively, first-time adult users selected flavored snus or smokeless tobacco products in each wave less than first-time youth users.

1. INTRODUCTION

The FDA recently announced impending regulation of the availability of flavored tobacco products given their possible role in tobacco initiation and their attractiveness to youth. Studies on flavored tobacco products have increased in recent years with a considerable number of reviews already available. An overview of reviews is presented to consolidate information on flavoring agents used in tobacco products, particularly when related to youth initiation and preferences. Noting a lack of reviews on the efficacy of flavored tobacco bans, a systematic search and review of the evidence was conducted. Additionally, the systematic search revealed studies on discrete choice experiments assessing the role of flavor in product selection. As these studies have not been discussed in previous reviews, a synthesis of discrete choice experiment findings is also presented. These studies are reviewed to understand whether the availability of flavored tobacco products increase tobacco initiation, with a focus on differences by age. Lastly, the proportion of first-time users who used flavored tobacco products was calculated using data from the latest Population Assessment of Tobacco and Health Study (PATH).

1.1 Funding

Ramboll was asked and funded by Swedish Match to conduct a review of the literature on the potential relationship between flavorings used in tobacco and nicotine products and perceived "attractiveness" (or equivalent). The funders had no role in the study design, data collection, and analyses contained in this review.

2. OVERVIEW OF RESULTS FROM SYSTEMATIC REVIEWS

2.1 Introduction

The volume of published studies on the role of flavor in perception, initiation, and maintenance of tobacco use has increased in recent years. Nine reviews related to tobacco flavors have been published in the past four years (Crowley 2015; Durmowicz 2014; Feirman et al. 2016; Hoffman et al. 2016; Huang et al. 2017; Kowitt et al. 2017; Romijnders et al. 2018; Schneider et al. 2016; Zare et al. 2018). These studies have variety in their inclusionary criteria as some studies focus on only the US, others focus on qualitative data, others expand to include all e-cigarette attributes beyond flavorings, and others focus on non-menthol tobacco flavors. The available reviews analyzed data based on region, tobacco use and age, perceptions/attitudes towards flavors, and harm perceptions of flavors. The limitations that were most often discussed regarding the available body of evidence included a lack of longitudinal data, preference data for flavored smells, specificity in tobacco product type, and specificity in dual use status.

2.2 Methods

PubMed and Scopus were searched for studies related to flavored tobacco reviews. 218 results were initially found. After removal of duplicates there were 181 original results. Abstracts were initially screened according to their title, abstract, and key words. Studies were included for full text review when they reviewed the role non-menthol flavors played for youth and adult selection of tobacco products. Nine reviews were identified. One review was included that was referenced by another review (Romijnders et al. 2018). Two studies (Crowley 2015; Schneider et al. 2016) were included that were previously identified in a non-systematic review of the literature, and the remaining six were identified using the search strategy provided in Table 1 below (Durmowicz 2014; Feirman et al. 2016; Hoffman et al. 2016; Kowitt et al. 2017; Huang et al. 2017; Zare et al. 2018). The non-systematic search was initially conducted to identify all flavor-related primary studies, the details of which are provided in Appendix A. After conducting this search, we identified several recently published relevant reviews, so we changed the scope of this evaluation to include a review of those, in addition to evaluations of specific topics not covered in those reviews (described in Sections 3, 4, and 5). Three of the nine revews provided detailed quantitative results of the underlying studies in supplementary tables (Feirman et al. 2016; Huang et al. 2017; Romijnders et al. 2018). This data, as reported by the review authors, has been reproduced in Appendix B of this report.

Additionally, the National Academies of Sciences (2018) recently published a review of the "Public Health Consequences of E-cigarettes", which was not included in this overview due to a focus on flavorant toxicity rather than flavor's role in initiation. Nevertheless, in their introduction to the section on flavorant toxicity (p. 173), they noted that "Broadly speaking, flavored tobacco use is associated with younger age; consumers perceive flavored tobacco products more favorably", as well that "Flavors appear to hold value to users". These comments were based on two systematic reviews (Kowitt et al. 2017; Feirman et al. 2016) included in this overview and eight primary studies (Four cross-sectional studies, two experiments, one willingness-to-pay study, and one mixed-methods study).

A report by the FDA (2013) that focused on menthol's role in initiation was excluded due to its sole focus on menthol flavoring in initiation. Notably, they found that "Prevalence data from cross sectional studies make a case for the involvement of menthol in the initiation process; all six studies found that

youth/younger smokers were more likely to smoke menthol cigarettes as compared to older smokers" (p. 96)

Table 1: Databases and Search Queries for Flavor-related Reviews		
Database	Search Query	Notes
PubMed	(flavor* OR flavour* OR "Flavoring Agents"[Mesh]) AND ("Tobacco Products"[Mesh] OR tobacco OR cigarette* OR e-cig* OR ENDS OR nicotine OR hookah OR snus OR snuff OR waterpipe OR cigar* OR vape OR vaping OR smoke* OR PREP OR "potential reduced exposure products") AND Review[ptyp]	113 results (12/18/18)
Scopus	TITLE-ABS-KEY ((flavor* OR flavour* OR flavoring AND agents) AND ("Tobacco Products" OR tobacco OR cigarette* OR e- cig* OR ends OR nicotine OR hookah OR snus OR snuff OR waterpipe OR cigar* OR vape OR vaping OR smoke* OR prep OR" potential reduced exposure products")) AND (LIMIT-TO (DOCTYPE, "re"))	105 results (12/18/18)

2.3 Literature Summaries

Durmowicz (2014) systematically reviewed 12 articles on the impact of electronic cigarettes on children published up to 2013. Search terms included cognates for ENDS, e-cigarettes, and youth (less than 18 years old) published in five databases (Web of Knowledge, PubMed, SciFinder, Embase, and EBSCOhost), as well as inclusion of two state surveys and adverse events reported to the FDA. Results were categorized into regions of which six were US-based cross-sectional studies. The authors concluded that data on the impact of e-cigarettes was limited at the time, though awareness of e-cigarettes was high, and use is increasing rapidly. Flavoring was only mentioned in one U.S study (Pepper et al. 2013) that showed that "willingness to try e-cigarettes was lower in non-smokers and not affected by the presence or absence of flavourings."

Crowley (2015) issued a position paper on behalf of the American College of Physicians that (non-systematically) reviewed the literature on electronic nicotine delivery systems (ENDS). Search terms included "electronic cigarettes," "e-cigarettes," "ecigs," and "electronic nicotine delivery systems" to identify literature in PubMed, Google Scholar, news articles, policy documents, and web sites. Results were reported based on policy recommendations regarding oversight, taxation, flavorings, promotion, indoor and outdoor use, and research. Seven sources regarding flavor were reviewed that discussed internal tobacco company documents regarding flavor (two papers), the use of the same chemical flavorants in candy, a cross-sectional study concluding that "those most likely to use flavored products are also the most at risk of developing established tobacco-use patterns that persist through their

lifetime" (Villanti et al. 2013), lower harm perception (uncited), wide flavor availability popular in youth (NYT article), and high exclusive use of flavored tobacco in youth compared to adults (cites two conference posters that cannot be found). Crowley (2015) concluded that "characterizing flavors should be banned from all tobacco products, including ENDS." The author also reviewed 11 sources regarding the use of ENDS in adolescents and the possible link to cigarette initiation, however they did not report on the role of flavor.

Feirman et al. (2016) systematically reviewed 32 articles on use and attitudes toward non-menthol flavored products (excluding nicotine replacement products) in the United States published up to 2013. Their search terms focused on flavor and tobacco product cognates to identify literature in five databases (PubMed, CINHAL, Embase, LILACS, PsycINFO), gray literature, conference abstracts, manual searching, or by experts. Results were broken down into flavored tobacco use topics including age (six studies), flavored tobacco use by tobacco use status (five studies) (e.g., current use, dual use, non-use), attitudes towards flavored tobacco (13 studies), flavored tobacco use prevalence (11 studies), and qualitative (focus group) studies (six studies).[a] Detailed study results by category, as reported by the review authors, have been reproduced in Appendix B. The authors overall concluded that the observational, experimental, and quasi-experimental evidence "highlight the association between flavored tobacco use and young age, and they indicate that participants may perceive flavored tobacco products more favorably than nonflavored products." The qualitative evidence reviewed further supports that "flavoring in tobacco products is an attractive trait." The review recommended that future studies incorporate how flavor may differ across products and how specific flavors may appeal to different groups. The authors identified a need to evaluate local-level flavor bans (New York City, Providence, Maine), product-specific data, and longitudinal data to understand whether flavored tobacco use leads to non-flavored tobacco use. The authors noted that the available evidence suggests that non-flavored tobacco use may predict flavored tobacco use, but that "additional research is needed to determine whether converse is true."

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[a] The following statements summarize the interpretations of studies for each category in Feirman et al. (2016)
Flavored Tobacco Use and Age: "Research suggests that flavored tobacco use is associated with young age." National samples show higher prevalence at younger age, while one study that compared age groups showed a significant association comparing 18-24 year olds with 25-34 year olds. A study performed in military recruits did not confirm these results. Two studies compared mean age of flavored vs non-flavored group showed no significant associations.
Flavored Tobacco Use and Tobacco Use Status: "These data suggest that users of certain nonflavored products may be more likely than nonusers of those products to have tried or currently use flavored tobacco; additional research should be conducted to determine if the converse is true." Additionally, "flavoring in tobacco products may facilitate maintenance of tobacco use, but this phenomenon may differ by product."
Attitudes: "Thirteen studies examined attitudes toward flavored tobacco products. Of these studies, seven provided data on preferred flavor of tobacco and six found that fruit and mint flavors were popular". Additionally, "Evidence from studies examining perception of the product suggests that flavoring may give respondents a more favorable perception of these products. This finding was consistent across three studies that differed with regard to study design and analytic approach
Flavored Tobacco Use Prevalence: Prevalence in eleven studies on flavored tobacco use ranged from "as low as 2.0% (95% CI ±0.3) for current kretek use among middle school students to as high as 79.4% for ever use of mint smokeless tobacco among current smokeless tobacco users."
Qualitative Studies: All six qualitative studies presented evidence that characterizing flavors were an attractive attribute in users and non-users of these products.

Hoffman et al. (2016) systematically reviewed 59 articles on flavor preference differences between adults and children. Their search terms focused around the concepts of flavor, products, preferences, and populations in four databases (PubMed, EMBASE, Web of Science, and PsycINFO). The results were broken down into six tastes (sweet, salty, sour, bitter, umami, and fat) and three smells (fruit/herbal/spices, tobacco/coffee, and other). The authors concluded that sweet preferences were higher in children and adolescents than adults based on 24 studies. Preferences for young people included cherry, candy, strawberry, orange, apple, and cinnamon. Children, adolescents, and elder adults preferred salty tastes more than intermediate age groups based on 11 studies. Results for other taste categories and odors were not clear. Bitter tastes (the category for tobacco) was the least preferred taste in every age category. The results of some studies suggest that adding sugar or sodium salt can reduce the initial aversion to bitter taste, which persists after sweetness is removed. This has implications with respect to initiation, and continued use of tobacco or nicotine products, even in the absence of sweet or salty flavors. The authors also noted other evidence that suggests that the ability to mix different flavors is itself an attractive feature of e-cigarettes. Furthermore, the authors identified a need for more research on preference for flavored smells. The included studies spanned eight decades and a mix of self-reports and sensory tests in different media.

Schneider et al. (2016) non-systematically reviewed literature to describe and synthesize disparate hypotheses on initiation of e-cigarettes and progression to cigarette smoking. The authors combined different hypotheses of initiation: flavor availability, health risks, lower prices, role models (including in advertising), ease of concealment, and social acceptability. The authors also describe hypotheses for transition to cigarettes: addiction, accessibility (same vendor/source for cigarettes as e-cigarettes), and experience ("training" for cig use). Lastly, the authors considered "external" effects, such as individual predisposition, socialization, and renormalization of smoking behavior. They recommend prospective cohort studies to evaluate transition processes and further qualitative interviews with adolescents to understand the absolute and relative contribution of each hypothesis.

Kowitt et al. (2017) systematically reviewed 20 studies that qualitatively evaluated perceptions and experiences with flavored non-menthol tobacco products. Their search terms focused on the concepts of "tobacco products" and "flavors" using four databases (PubMed, Embase, PsycINFO, CINAHL) published up to April 2016. The authors concluded that "The majority of studies, regardless of product type, reported positive perceptions of flavored tobacco products, particularly among young adults and adolescents." Additionally, there was lower perception of harm compared to cigarettes and "participants mentioned flavors as specifically leading to their experimentation and/or initiation of flavored tobacco products." The authors briefly concluded that their "results suggest the potential of flavors to introduce youth to other tobacco products, but that these patterns may differ by type of product first used." Limitations cited by the authors included a lack of any studies on flavors in smokeless tobacco products, the inability to assess the prevalence of stated beliefs due to the qualitative nature of the study, and the lack of individual level details of participants in the study.

Huang et al. (2017) systematically reviewed 40 studies on the impact of non-menthol flavors in tobacco products on tobacco use perceptions and behaviors among youth, young adults and adults. Search terms included variants of "flavor", "tobacco products", and "smoking" to identify studies published up to April 2016 in four databases (PubMed, Embase, PsycINFO and CINAHL). The authors excluded publications that were in a foreign language, not peer-reviewed, qualitative, assessed menthol-flavored products only, or did not contain original data. Despite no limits on region, over half

of the identified studies were US-based. Most studies identified were cross-sectional with only one using a longitudinal design. The authors concluded that flavor descriptors on packaging made a product more appealing and perceived as less harmful by tobacco users and non-users. The authors summarized their conclusions: "Flavours in tobacco products seem to have a universal and rather strong appeal to youth and young adults interested in initiating tobacco use or experimenting with different products due to the variety and availability of flavors [8 studies], are reported as a reason for using most tobacco products [7 studies], and appear to play a more important role in the use of e-cigarettes, hookah, little cigars and cigarillos among younger people [3 studies]." Detailed study results, as reported by the review authors, have been reproduced in Appendix B. The results are limited by studies that were not designed to assess flavor as the primary variable. This may have led to a lack of power causing the systematic review to underestimate the impact of flavor due to statistically non-significant results.

Zare et al. (2018) systematically reviewed 66 studies on consumer preference for the three main e-cigarette attributes consisting of flavor, nicotine strength, and type. Search terms used included "electronic cigarettes", "e-cigarettes", "electronic nicotine delivery systems", "E-cig", and "E-cigarette" to identify a broad range of studies published up to January 2018 in five databases (PubMed, MEDLINE, Web of Science, PyscINFO, and CINAHL Plus) and 11 journals that publish tobacco-related studies. The authors included publications that were written in English, peer-reviewed, and addressed e-cigarette, flavor, and/or design type. In regards to flavor, the authors discussed flavor preference in adolescents (<18) years, young adults (18-24 years), and adults (> 24 years), as well as the impact of flavors on quitting smoking and on health. The thirteen studies (one longitudinal survey, two focus group studies, six surveys, and four repeated cross-sectional surveys) on adolescents' preference for flavor found that most adolescents started with flavored e-cigarettes, positively regarded flavor variety, considered flavor as an important factor for initiation, considered tobacco flavor less favorably, and that fruit and sweet flavors were more likely to be tried by never smoking adolescents than smokers trying to quit. Only two studies of the thirteen concerned with adolescents' preference for flavor found results that flavors did not increase willingness to try e-cigarettes or appeal to non-smoking teenagers. Importantly, they also reported adults preferred sweet flavors too and dislike bitterness or harshness, but "adult smokers (especially men) liked tobacco flavor the most, followed by menthol and fruit flavors." Overall, the authors drew four other principal conclusions: 1) several flavors were associated with decreased harm perception, while tobacco flavor was associated with increased harm perception, 2) user control of nicotine is preferable, 3) emergent weak evidence between flavors and nicotine strength, and 4) newer- generation device designs were preferred. The conclusions in this review were limited by heterogeneity in reported age ranges in the included studies (e.g. the results of a study with an age-range of 18-30 years was considered in the young adult category by this review) and a focus on studies in the United states (53 out of 66 studies). They also identified a research gap in the assessment of certain flavors, such as strawberry and "coolness." Another research gap is the interaction between product designs with flavors or nicotine strength.

Romijnders et al. (2018) systematically reviewed 72 articles on "attractiveness" of e-cigarettes in terms of perceived risks, perceived benefits, and reasons for use. Their search terms included e-cigarette "perception", "reason", "opinion", "smoking cessation" in two databases (MEDLINE and Scopus) published up to February 2018. With regards to flavor and taste, the authors concluded on the basis of 12 studies that "fruit or candy flavored e-liquids were perceived as less risky compared to tobacco flavored e-liquids," and that "this perception of reduced harm could lead to use or, vice versa,

by initiating e-cigarette use, the perception of harm may decrease...” In terms of age differences: "Adults’ perceptions and reasons for e-cigarette use are often related to smoking cessation, while youth like the novelty of the product." Detailed study results, as reported by the review authors, have been reproduced in Appendix B. Limitations included the lack of study of risk perceptions over time and clear differentiation between dual users and smokers.

2.4 Summary Table

Table 2: Reviews related to the role of flavor in tobacco use or initiation

Reference	Author Categories	Studies flavoring related results relied upon	Conclusion	Limitations
Durmowicz (2014)	Regional: France, Hungary and Lithuania, South Korea, Poland, and US	One longitudinal cross-sectional study (Pepper et al. 2013)	Data on the impact of e-cigarettes was limited at the time, though awareness of e-cigarettes was high, and use is increasing rapidly. "The impact of product flavourings and marketing on youth e-cigarette initiation and ongoing use is also inadequately characterised."... "The extent to which experimentation with e-cigarettes in youth will result in nicotine dependence and subsequent use of other tobacco products is unknown"	Limited evidence on e-cigarettes, and more so on flavorings in e-cigarettes as there was only one relevant study. More data needed on youth perception to evaluate initiation risks. Used only publicly available literature. No synthesis of results from different regions. No focus on flavor, but on e-cigarettes and youth generally.
Crowley (2015)	Oversight, taxation, flavorings, promotion, indoor and outdoor use, and research	2 Internal tobacco company documents 1 study on chemical composition of flavorants and candy 1 cross-sectional study (Villanti et al. 2013) 1 study on harm perception (uncited) 1 NYT article on popularity among youth of wide flavor availability 2 conference posters (No related published paper found)	The position paper by the American College of Physicians discussed several aspects of ENDS oversight, taxation, advertisement, research needs, and quality control. In their discussion of flavor, they discussed internal tobacco company memoranda discussing the youth orientation of flavor products. As well as the use of common candy chemical flavorants in tobacco products. The one peer-reviewed cross-sectional study showed "young adults were more likely to use flavoured tobacco products". Another two conference posters showed that young adults "exclusively" favored flavored electronic cigarettes compared with just 65% of older survey respondents. Based on their non-systematic review they concluded that "characterizing flavors should be banned from all tobacco products, including ENDS."	Not a systematic review Included studies/references that had not undergone peer review No focus on flavor or youth, but ENDS generally
Feirman et al. (2016)	Flavored tobacco use by age (six studies). Flavored tobacco use by tobacco use status (five studies) Attitudes towards flavored tobacco (13 studies) Flavored tobacco use prevalence (11 studies) Qualitative (focus group) studies (six studies).	**32 studies evaluated:** 14 cross-sectional studies 8 quasi-experimental and experimental studies 6 qualitative studies: 1 pooled study 3 case report/case series studies	The authors concluded that the observational, experimental, and quasi-experimental evidence "highlight the association between flavored tobacco use and young age, and they indicate that participants may perceive flavored tobacco products more favorably than nonflavored products." The qualitative evidence reviewed further supports that "flavoring in tobacco products is an attractive trait." The authors noted that the available evidence suggests that non-flavored tobacco use may predict flavored tobacco use, but that "additional research is needed to determine whether converse is true."	Results from other countries not reviewed and focus on use and attitudes ignored relationships between socioeconomic study, race, and other potentially elucidating variables. Did not examine an overall quality assessment of included studies. Lack of any studies on flavors in smokeless tobacco products The inability to assess the prevalence of stated beliefs due to the qualitative nature of the study. Lack of individual level details of participants in the study. Lack of brand-, flavor-, and product-specific data Substantial heterogeneity in studies with varied

				methodologic quality Reliability and validity of measures not fully established... self-reported measures may be problematic when used in adolescent populations. Comparator products in four studies not explicitly described.
Hoffman et al. (2016)	The results were broken down into six tastes (sweet, salty, sour, bitter, umami, and fat) and three smells (fruit/herbal/spices, tobacco/coffee, and other) in three age groups (children, adolescents, adults) 2 papers described sweet taste preference among adolescents 6 papers compare taste preference with adults 9 papers on sweet taste preference in adults 6 papers find a negative correlation of sweet foods and age 8 papers on bitter taste preference in youth and adults 6 papers fruit/herbal/spice odors across age ranges 3 papers tobacco and coffee odors in youth and adults	The included studies spanned eight decades and a mix of self-reports and sensory tests in different media. **Twenty-eight studies included:** 2 Cross-sectional 1 Nested case-control 4 Panel/Cohort 20 Experiments 1 Mixed-methods study	The authors concluded that sweet preferences were higher in children and adolescents than adults based on 24 studies. Preferences for young people included cherry, candy, strawberry, orange, apple, and cinnamon. Children, adolescents, and elder adults preferred salty tastes more than intermediate age groups based on 11 studies. Results for other taste categories and odors were not clear. Bitter tastes (the category for tobacco) was the least preferred taste in every age category. The results of some studies suggest that adding sugar or sodium salt can reduce the initial aversion to bitter taste, which persists after sweetness is removed. This has implications with respect to initiation, and continued use of tobacco or nicotine products, even in the absence of sweet or salty flavors. The authors also noted other evidence that suggests that the ability to mix different flavors is itself an attractive feature of e-cigarettes.	Does not directly deal with flavor preferences of tobacco products by age, but what food, beverage, and candy flavor preferences change age and may translate to tobacco products Due to lack of standardization between studies no consistent cutoff for the age categories of children, adolescents, or adults. Although, specificity was made when possible.
Schneider et al. (2016)	**Flavor hypothesis (3 studies)** Health hypothesis (8 studies) Price hypothesis (1 study): 30 Role model hypothesis (12 studies) Concealment hypothesis (3 studies) Acceptance hypothesis (1 study) Addiction hypothesis (8 studies) Accessibility hypothesis (1 study) Experience hypothesis (2 studies) Liability hypothesis (11 studies) Renormalization hypothesis (3 studies)	**3 Flavor-related studies:** 1 Cross-sectional 1 Expert workshop 1 Expert Review	The authors combined different hypotheses of initiation: flavor availability, health risks, lower prices, role models (including in advertising), ease of concealment, and social acceptability. The authors also describe hypotheses for transition to cigarettes: addiction, accessibility (same vendor/source for cigarettes as e-cigarettes), and experience ("training" for cig use). Lastly, the authors considered "external" effects, such as individual predisposition, socialization, and renormalization of smoking behavior.	They recommend prospective cohort studies to evaluate transition processes and further qualitative interviews with adolescents to understand the absolute and relative contribution of each hypothesis.
Kowitt et al. (2017)	Hookah (10 studies) E-cigarettes (6 studies) Little Cigars and Cigarillos (2 studies) Other tobacco products (3 studies)	**20 qualitative studies included:** 9 Focus groups 9 One-on-one interviews 2 Both Focus groups and one-on-one interviews	"The majority of studies, regardless of product type, reported positive perceptions of flavored tobacco products, particularly among young adults and adolescents." Additionally, there was lower perception of harm compared to cigarettes and "participants mentioned flavors as specifically leading to their experimentation and/or initiation of flavored tobacco products." The authors briefly concluded that their "results suggest the potential of flavors to introduce youth to other tobacco products, but that these patterns may differ by type of product first used."	A lack of any studies on flavors in smokeless tobacco products, the inability to assess the prevalence of stated beliefs due to the qualitative nature of the study, and the lack of individual level details of participants in the study.
Huang et al. (2017)	11 studies regarding taste, appeal, and risk perceptions:	**40 quantitative studies**	The authors concluded that flavor descriptors on packaging made a product more appealing and	The results are limited by studies that were not designed to assess flavor as the primary variable.

	10 studies regarding preference for flavored products: 6 studies regarding expectancies and beliefs: 7 studies regarding flavor as a reason for use: 12 studies regarding intention to try: 2 studies regarding progression to regular use: 3 studies regarding dual/poly use: 4 studies regarding quit intention and quitting behavior:	28 Cross-sectionals 2 DCE 4 Experimental 3 Experimental cross-sectional 1 Longitudinal Panel Survey 1 Mixed-method 1 Pooled study	perceived as less harmful by tobacco users and non-users. The authors summarized their conclusions: "Flavours in tobacco products seem to have a universal and rather strong appeal to youth and young adults interested in initiating tobacco use or experimenting with different products due to the variety and availability of flavors, [8 studies] are reported as a reason for using most tobacco products, [7 studies] and appear to play a more important role in the use of e-cigarettes, hookah, little cigars and cigarillos among younger people.[3 studies]".	This may have led to a lack of power causing the systematic review to underestimate the impact of flavor due to statistically non-significant results.
Romijnders et al. (2018)	Risk Perceptions related to e-cigarettes Perceived benefits of e-cigarettes Reasons for e-cigarette use	**Two focused on youth:** **1 longitudinal cross-sectional** **1 focus group** **Ten focused on adults:** 6 cross-sectionals 4 focus group	Concluded on the basis of 11 studies that "fruit or candy flavored e-liquids were perceived as less risky compared to tobacco flavored e-liquids," and that "this perception of reduced harm could lead to use or, vice versa, by initiating e-cigarette use, the perception of harm may decrease...". In terms of age differences: "Adults' perceptions and reasons for e-cigarette use are often related to smoking cessation, while youth like the novelty of the product."	Limitations included the lack of study of risk perceptions over time and clear differentiation between dual users and smokers
Zare et al. (2018)	Flavor (48 studies): Adolescents' preference (13 studies): One longitudinal survey, Two focus group studies Six surveys, and Four repeated cross-sectional surveys Young adults' preference (11 studies) Adults' preference (13 studies) Flavors and smoking cessation (4 studies) Flavors on health and harm perception (7 studies) Nicotine Strength (22 studies) Design type (14 studies)	**66 studies:** **6** focus groups/interviews 14 experiment or lab tests 30 surveys 7 repeated cross-sectionals 1 longitudinal survey 5 studies assessing sales or online content 3 systematic reviews	"Adolescents could consider flavor the most important factor trying e-cigarettes and were more likely to initiate vaping through flavored e-cigarettes. Young adults overall preferred sweet, menthol, and cherry flavors, while non-smokers in particular preferred coffee and menthol flavors. Adults in general also preferred sweet flavors (though smokers like tobacco flavor the most) and disliked flavors that elicit bitterness or harshness."	The conclusions in this review were limited by heterogeneity in reported age ranges in the included studies (e.g. the results of a study with an age-range of 18-30 years was considered in the young adult category by this review) and a focus on studies in the United states (53 out of 66 studies). They also identified two research gaps: 1) lack of assessment of certain flavors, such as strawberry and "coolness", and 2) lack of studies on the interaction between product designs and flavors or nicotine strength.

2.5 Discussion/Conclusion

The wide availability in device types, tobacco products, flavor variation, and brands complicate synthesis of the evidence. However, the overall trends in the findings from a growing amount of focus groups, cross-sectional studies, and experimental evidence suggest that youth (and younger age groups) compared to adults have higher preference of flavors and higher use of flavored products. This trend is bolstered by the potential impact of flavoring on other variables previously associated with initiation. For example, flavor (and associated product descriptions) has shown effects on harm perception in youth, appeal of packaging, social acceptability, and novelty. Overall, the direct and indirect evidence would suggest flavors play a larger role in tobacco initiation for youths than in adults.

2.6 Limitations

Most studies still rely heavily on cross-sectional studies as noted in the summary table 2, however two of the most recent reviews (Zare et al. 2018; Huang et al. 2017) each included experimental or lab test evidence related to flavored tobacco use. The most recent review (Zare et al. 2018) identified 16 studies using experiments or lab tests. However, none were available among the subset of studies directly related to adolescent preferences likely due to ethical concerns. Studies related to adolescent preferences included one longitudinal survey, two focus group studies, and ten cross-sectional studies.

One unique review (Hoffman et al. 2016) focused almost exclusively on sensory tests in different media to compare preferences between youth and adults. These did not directly assess flavored tobacco products, but rather intended to isolate the effects of flavorants. This avoids ethical concerns with evaluation of flavorant preferences in youth compared to adults. The authors concluded that sweet preferences were higher in children and adolescents than adults based on 24 studies. Preferences for young people included cherry, candy, strawberry, orange, apple, and cinnamon

An evaluation of the role of flavor specifically in tobacco initiation would be facilitated by consideration of how it fits in with all risk factors linked to initiation. In a nonsystematic review, Schneider et al. (2016) hypothesized health risk perception, role models, ease of concealment, and social acceptability as important factors related to tobacco initiation. In particular, several studies have shown an association between flavor and harm perception. For example, Zare et al. (2018) on the basis of seven studies noted that "several flavors were associated with decreased harm perception (e.g., sweet and fruit) while tobacco flavor was associated with increased harm perception".

An area that has been mentioned by a couple of reviewers that a systematic review has not focused on is the changes in tobacco use in cities and countries that have banned flavored tobacco in some shape or form. This is assessed in the next section.

3. IMPACT OF FLAVOR BANS

3.1 Introduction

The enforcement of various policies banning the use of flavors in certain or all tobacco products present the opportunity to observe a natural experiment through interrupted time series analysis or pre- and post- survey data. This type of study evaluates whether significant changes occurred in the level or trends of a variable of interest after a specific time point. We hypothesized that some researchers have evaluated the impact of these bans and noted that a previous review had called for evaluation of the impact of pre-existing regulations. No existing reviews or synthesis of regulatory impact of flavor bans on change in tobacco use or sales were available in the literature prior to this study.

Various local and national policies have been enacted in different jurisdictions throughout the world. In 2009, the U.S. FDA enacted a policy banning flavored (excluding menthol) cigarettes nationally. In 2010, New York City banned all tobacco flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, and roll-your-own tobacco, and dissolvable tobacco. In 2010, Canada banned all flavored (excluding menthol) cigarettes, cigarillos/little cigars, and blunt wraps. The repercussions of these bans on youth use and tobacco sales were evaluated.

3.2 Methods

PubMed and Scopus were searched for studies related to differences in tobacco sales/use before and after a ban of flavored tobacco products. 411 documents initially found, after duplicates removed there were a total of 395 documents for abstract review. Abstracts were initially screened according to their title, abstract, and key words. Studies were included for full text review when they were original peer-reviewed studies that examined a change in tobacco product use after a flavor ban or when they discussed a flavor ban but what they measured was unclear because of the abstract. Thirteen studies were moved to full article review, after which seven studies were included in this review. Five studies related to sales volume and three studies related to youth tobacco use. The six excluded studies discussed policy options generally, showed post-ban survey statistics only, or focused on retail compliance. An abstraction table of the tobacco use study results is included in Appendix C.

Table 3: Databases and Proposed Search Queries for Flavored Tobacco Ban

Database	**Search Query**	**Notes**
PubMed	("Smoking/legislation and jurisprudence"[Mesh] OR "Tobacco Industry/legislation and jurisprudence"[Mesh] OR "Tobacco Products/legislation and jurisprudence"[Mesh] OR "public policy" OR "ban" OR "restriction" OR "legislation") AND ("Flavoring Agents"[Mesh] OR flavor* OR flavour*) AND (tobacco OR cigarette OR smok* OR ENDS OR snuff OR snus OR e-cig* OR "potential reduced exposure products" OR nicotine OR PREP)	158 results (12/27/18)
Scopus	TITLE-ABS-KEY (("Smoking/legislation and jurisprudence" OR "Tobacco Industry/legislation and jurisprudence" OR "Tobacco Products/legislation and jurisprudence" OR "public policy" OR policy	357 results (12/27/18)

	OR law OR legislation OR jurisprudence OR "ban" OR "restriction" OR "legislation") AND ("Flavoring Agents" OR flavor* OR flavour*) AND (tobacco OR cigarette OR smok* OR ends OR snuff OR snus OR e-cig* OR "potential reduced exposure products" OR nicotine OR prep))	

3.3 Literature Summaries

3.3.1 Changes in Youth Use

Courtemanche et al. (2017) estimated the impact of the 2009 US FDA ban on the use of flavored cigarettes (excluding menthol) by a representative sample of middle and high school students. They used nine National Youth Tobacco Surveys conducted between 2009 and 2013 for a total of 197,834 respondents aged 11-19 years old. They controlled for demographic characteristics, prices of tobacco products, the unemployment rate, and the quadratic time trend. After control for confounders, the flavored cigarette ban was associated with a "17.1% reduction in the likelihood of being a cigarette smoker ($p<0.001$)" and a "45% increase ($p<0.001$) in the probability that a smoker usually used menthol cigarettes." The ban was associated with an 14.2% increase ($p<0.001$) in the use of at least one non-cigarette tobacco product (cigars, smokeless tobacco, or pipes). However, the ban was also associated with a 6.1% reduction ($p<0.001$) in the probability of using any tobacco including cigarettes. This evidence demonstrates possible substitution of flavored cigarettes with menthol cigarettes and other non-cigarette tobacco products. The study data did not distinguish between flavored and non-flavored non-cigarette tobacco products, although the authors hypothesize this was the reason behind product substitution. Despite increases in non-cigarette tobacco products, the overall use of tobacco declined, suggesting the flavor ban had the intended impact. Notable limitations of this study include the lack of survey questions on e-cigarette and hookah use, insufficient post-ban time periods to report changes in post-ban trends.

Farley and Johns (2017) looked at the impact of the 2010 NYC ban of all flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, and roll-your-own (RYO) tobacco, and dissolvable tobacco by analyzing a representative sample of NYC high school students aged 13-17 years and retail sales of smokeless, cigar, and pipe/roll-your-own tobacco. A summary of the sales data is in the following section. The youth behavior data came from two NYC Youth Risk Behavior Surveys with a total of 1,800 and 9,439 public high school students conducted in 2010 and 2013, respectively. Analysis of survey data controlled for sex, race/ethnicity, age, and other tobacco product use when appropriate. After, adjustment, youth were 28% less likely to use any tobacco (OR=0.72; 95% CI: 0.62-0.85) and 37% less likely to ever use flavored tobacco (OR=0.63; 95% CI: 0.52-0.77). There was a statistically *non-significant* increase in current smoking of cigars and cigarettes (OR=1.31; 95% CI: 0.94-1.84). The inferences were limited by use of only two time points and changes in the number of examples given in questions regarding use of flavored products. Although, this may have contributed to a lower estimate of flavored tobacco use, the authors noted the excluded examples of "blunts, chewing tobacco, snus, snuff, dip, or dissolvable tobacco pellets" have a much lower prevalence of use among youth than cigarettes and cigars.

Nguyen and Grootendorst (2014) assessed the impact of a 2010 Canadian flavored cigarillo ban and a sales restriction on minimum cigarillo sales units on youth use of cigarillos and cigars. They used

monthly data from the nationally representative Canadian Tobacco Use Monitoring Survey from 2007 to 2011. This surveys about 20,000 individuals over the age of 15 annually. This resulted in just over 46,000 observations of individuals 15-24 years of age. In their analysis, they controlled for cigarette smoking status, age, sex, language, education, province, and season. After control for confounders, the flavor ban was associated with a 2.29 percentage point decline ($p<0.01$) in past 30-day use of cigarillos, a 4.32 percentage point increase ($p<0.05$) in 30-day abstinence from cigarillos, and a 3.08 percentage point ($p<0.01$) decline in ever use of cigarillos by individuals 15-24 years of age. There was no statistically significant change in the trend of use for cigarillos. Comparatively, there was no statistically significant change in ever-use or past 30-day use of regular cigars. However, there was a statistically significant increase in the trend of regular cigar past 30-day use and ever-use of 0.08 ($p<0.05$) and 0.22 ($p<0.01$) percentage points per month. This changes the direction of the pre-policy trend of -0.07 ($p<0.01$) and -0.17 ($p<0.01$) percentage units per month for past 30-day use and ever-use of regular cigars, respectively. Overall among youth and young adults (15-24) there was a decrease in ever use of all cigar types of 2.25 percentage points ($p<0.01$) that seems driven by a decline in cigarillo usage, however the trend of cigar usage was reversed from declining pre-ban to increasing post-ban. Nguyen and Grootendorst (2014) additionally assessed these outcomes among older adults aged 25-65 years of age that contrasted with results among youth and young adults. There was no statistically significant change in trends or levels of cigarillo past-30-day use, 30-day abstinence, or ever use. There were also no statistically significant changes in the levels or trends of ever use of regular cigars or ever use of all cigar types. There was a statistically significant decline of 0.37 percentage points ($p<0.01$) for past 30-day use of regular cigars. The flavor ban impacted youth and young adults differently from older adults, who experienced no significant changes except for a minor 0.37 percentage point decrease in past 30-day use of regular cigars. Notable limitations of this study include evaluation that does not distinguish youth from young adults, as well as results reflecting the combined impact of a flavored cigarillo ban and a 20-unit pack minimum requirement. Furthermore, the lack of data distinguishing flavored and non-flavored regular cigars and cigarillos inhibits the ability to know if the change in regular cigar use trends was driven by flavor availability in cigars.

3.3.2 Changes in Tobacco Sales

Chaiton et al. (2018) assessed the changes in quarterly cigar sales after the 2009 flavor (excluding menthol) cigarette and cigars (under 1.4 g, or with filter or non-spiral wrap) regulation in Canada using mandated reporting of manufacturer wholesales to Canadian retailers or wholesalers. In terms of changes in *level* of sales, they reported a 49.6 million (95% CI: −73.5 to −25.8) unit decline in overall sale of cigars, 59.2 million (95% CI: 86.0 to 32.4) unit decline in flavored cigars, and a statistically non-significant increase of 9.6 million units (95% CI: -1.3 to 20.5) in cigars without flavor descriptors. They also reported changes in the trend of all cigars, flavored cigars, and non-flavored cigars. The trend for all cigars and flavored cigars was previously positive and changed to a negative trend. The trend changed by -6.9 (95% CI: −8.1 to −5.7) million all cigar type units per quarter and -7.7 (95% CI: -8.9 to -6.5) million flavored cigars per quarter. The trend in non-flavored cigars seemed to flatten out as the previous decreasing trend of -0.8 (95% CI: -1.4 to -0.3) million per quarter pre-policy changed by 0.8 (95% CI: 0.2-1.3) million non-flavored cigars per quarter. Overall, the negative change in sales of cigars seemed driven by the decline in flavored cigars as it occurred despite non-significant increases in sales of non-flavored cigars. Furthermore, the policy was associated with a change to a downward trend of all cigars and flavored cigars, while associated with a positive change on the previous downward trend of non-flavored cigars. Notable limitations of this

study included the possible use of the wrong date of ban enforcement. The authors use the first quarter of 2010 as the critical point, however other sources point to an effective date of June 2010. This is mitigated by the use of sensitivity analyses varying the critical point one year pre- and post-the selected date, suggesting that the findings were insensitive to the later date. An additional limitation was the use of wholesale rather than retail data, which may limit knowledge of smaller provinces who may purchase from larger provinces instead of buying wholesale. This study also notably strengthened the case for policy attribution of effect by comparing the effects in two provinces that varied in strength of prior tobacco regulation finding that effects post-intervention was large and similar. This study also noted and graphed an increase in sales of brands with color descriptors but no flavor descriptors, however they did not provide the quantitative estimates. This provides evidence on use of colors as a signal for flavor to consumers.

Delnevo and Hrywna (2015) assessed the impact of the 2009 US FDA flavored (excluding menthol) cigarette ban on changes in clove cigar sales and import volume of cigars and cigarettes from Indonesia. Indonesia is home to Kretek International, the top producer of clove cigarettes and cigars sold in the United States. The authors chose to contextualize changes in cigars and cigarettes through a review of internal documents from Kretek International. Sales data was obtained for a weekly representative sample of convenience stores through the Nielsen Convenience Track system. Import volume data was obtained from the USDA Foreign Agricultural Service's Global Agricultural Trade System (GATS). Results showed a complete drop to zero of clove cigarette imports by 2010 from 532 million sticks imported in 2008. Meanwhile, imports of cigar sticks increased from 2.4 million in 2008 to over 656 million in 2010. Sales of clove cigar sticks showed a 748.60% increase from about 5.3 million in 2009 to about 39.9 million in 2010. The internal document review found that Kretek International stated they began developing clove cigars in 2007 to be "prepared for a seamless transition from Djarum Clove cigarettes to Djarum Clove cigars in the event of FDA ban on clove.", as well as to capitalize on excise tax disparities. They launched the product across the US in July 2009, two months prior to enforcement of the ban in September 2009. Overall, these results showed evidence for substitution of clove cigarettes by clove cigars buffered by Kretek International's arguable intent to circumvent potential future bans as well as enjoy tax benefits. A notable limitation of this study includes a lack of quantitative analysis of changes albeit this is mitigated by the large reported effects. Additional limitations include the assessment of sales from only convenience stores, the lack of differentiation between clove cigars and other cigars in the import data, and lastly that not all of Kretek International's internal documents were available. The two former limitations have mitigating factors as convenience stores are the largest retail channel for cigars, and prior to 2009, Indonesia produced a small volume of cigars.

Jo et al. (2015) reviewed changes in proportion of U.S. based internet cigarette vendors delivering flavored cigarettes or cigars following the U.S. FDA 2009 ban on flavored cigarettes. They additionally, assessed the impact the 2010 ban on misleading descriptors of light, low, or mild (LLM), however these results are not a focus of the review. They used cross-sectional surveys from early 2009, 2010, and 2011, along with web scrapping to identify likely internet cigarette vendors (ICVs), and lastly selected the 200 most popular ICVs from Alexa.com visitor traffic ratings. They reported consistent increases in the odds of selling clove cigars in 2010 and 2011 of 450% (OR=5.5; 95% CI: 2.36-12.80) and 385% (OR=4.85; 95% CI: 2.08–11.31) compared to 2009. There were no significant results for the odds of selling clove cigarettes. They found inconsistent results for flavored cigarettes and flavored little cigars. There was a statistically significant decline in flavored cigarettes of 36% (OR=0.64; 95%

CI: 0.42–0.96) and statistically significant increase in flavored little cigars of 71% (OR=1.71; 95% CI: 1.09-2.69) in 2010 compared to 2009. However, the odds of selling these products in 2011 compared to 2009 was statistically non-significant. Non-compliance continued in 2011 as 28.6% of US vendors sold flavored cigarettes and 2.9% of US vendors sold clove cigarettes. Overall, this provided evidence for an immediate but not sustained impact on the availability of flavored cigarettes and cigars, negligible sustained impact on clove cigarette availability, and a sustained increase in clove cigar availability. A notable limitation of this study is its focus on product availability and not actual sales volumes, hindering inference of the ban's impact on the actual user. An additional limitation is the potential for location misclassification due to different locations for online vendor functions (e.g. stated address, order processing, web hosting, order fulfillment).

Farley and Johns (2017) assessed the impact of the 2010 NYC ban of all flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, roll-your-own (RYO) tobacco, and dissolvable tobacco by analyzing a representative sample of NYC high school students aged 13-17 years and retail sales of smokeless, cigar, and pipe/roll-your-own tobacco. A summary of the youth behavior data is in the preceding section. The sales data came from NYC stores with greater than 2 million in revenue in a four-week period between 2008 and 2012. Analysis of sales data looked at mean inflation-adjusted dollar sales as an outcome and controlled for number of stores each year, and a continuous time variable to control for secular trends. After control for confounders, the flavor ban had a statistically significant association with an 86.8% ($p<0.000$) decline in sales of flavored non-cigarette tobacco products, 86.2% ($p<0.000$) decline in flavored cigars, and 91.1% ($p<0.000$) decline in flavored pipe and RYO. There was no statistically significant increase in sales of overall non-flavored non-cigarette tobacco products, however there were statistically significant increases in sales of non-flavored cigars of 5% ($p = 0.003$) and in sales of non-flavored pipe and RYO of 4% ($p=0.030$). Additionally, there was no statistically significant change in flavored or non-flavored smokeless tobacco products, although there was 102% increase in non-flavored smokeless tobacco. Analysis of sales trends showed no statistically significant post-ban flavored product trends but did show a statistically significant negative post-ban trend for sales of non-flavored products overall and across each non-flavored tobacco category. Overall, these results provide some evidence of an association of the flavor ban with substitution of flavored cigar, pipe, and roll-your-own tobacco products with their non-flavored analogues. The negative post-ban trend suggests that there may be a gradual impact on use of non-flavored tobacco products. A notable limitation of this study is the lack of reporting of changes in sales of a combined flavored and non-flavored category to evaluate the overall changes in tobacco use, which could have helped note if the decreases in flavored products overcame an increase in non-flavored products. A related notable limitation was the lack of quantitative comparison of results and trends with national sales data, which the authors briefly discuss as possibly attributable to increases in cigar and smokeless tobacco sales. Finally, the use of a non-random subset of sales data from only 922 stores with greater than $2 million in revenue prevents generalizability, as NYC has 9,000+ stores, many of which are small gas, convenience, or grocery stores. Some of these limitations are follow up on by Rogers et al. (2017)

Rogers et al. (2017) followed up on Farley and Johns (2017) due to three limitations: 1) a limited sample of gas/convenience stores (4%) and grocery stores (12%), the store types where the majority of consumers purchase tobacco products, 2) lack of a comparison area to account for secular trends, and 3) setting of date to first enforcement rather than notice of adoption may have resulted in missed compliance actions.

Rogers et al. (2017) assessed New York City's ban on flavored and non-flavored cigar sales in NYC, a comparison area, and the rest of the US. They used 2010-2014 Nielsen Retail Scanner data from a variety of retailers including grocery and convenience stores. In their analyses they assessed changes in average unit sales. Following the ban, changes in average sales of all cigar types differed by area. There was a significant 7.4% ($p<0.01$) decline in NYC, a significant 9.8% ($p<0.01$) increase in the comparison area, and a statistically non-significant 12% increase in the US. Analysis of flavored products showed expected significant declines of 31.8% ($p<0.01$) in NYC, while showing increases in the comparison area of 2.2% ($p<0.05$) and the US of 10.9% ($p<0.01$). The increases in flavored products in the comparison area and the US seem driven by increases in flavored cigars as there were statistically significant declines in flavored smokeless (respective 7.8%, $p<0.05$ and 18.4%, $p<0.05$) and roll-your-own tobacco (respective 33.2%, $p<0.01$ and 31.9%, $p<0.01$) in both locations. In NYC each flavored product had statistically significant decline, but flavored cigars appeared to have a lower decline (25.5%, $p<0.01$) compared to flavored smokeless tobacco (97.6%, $p<0.01$) and flavored roll-your-own tobacco (78.1%, $p<0.01$). Overall, these results show the flavor ban was associated with decreases in all cigar types despite persistent sales of flavored cigars. Use of comparison areas strengthen the case for attribution of results to the policy ban as sales of all cigars increased in the comparison area and the US (albeit statistically non-significant). This discrepancy in sales of all cigar types may be attributable to the statistically significant increase in flavored cigars in the comparison area and the US compared to the statistically significant decline in NYC. This study may have found relatively higher sales of flavored cigars either due to its follow up to flavors in products with ambiguous descriptors (e.g. "purple" instead of "grape" or concept flavors like "blue haze") or due to the increased sample of retailers compared to Farley and Johns (2017). The sample, however, was still limited by a lack of sales data from smaller grocery stores (less than $2 million), and corner stores (less than $1 million) who represent 57% of licensed tobacco retailers.

3.4 Summary Tables

3.4.1 Changes in youth use

Table 4: Impact of flavor bans on youth

Reference	Flavored Products Banned	Percent decrease in tobacco use	Percent increase in other tobacco use or sales	Notable Limitations	Notable Strengths
Courtemanche et al. (2017)	Flavored (excluding menthol) cigarettes	6.1% less likely of using any tobacco (p<0.001) 17.1% decrease in likelihood of using cigarettes (p<0.001)	45% increase in smokers using menthol cigarettes (p<0.001) 14.2% increase in the use of at least one non-cigarette tobacco product (p<0.001)	Assessed 11-19 years of age in middle and high school, which includes adults of legal age Did not have data on if increase in non-cigarette tobacco product use was flavored or non-flavored Insufficient information to assess changes in trends post-ban	Uniquely controlled for a quadratic time trend, unemployment rate, and prices of tobacco products Demonstrates possible substitution of flavored cigarettes on the national level
Farley and Johns (2017)	Flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, roll-your-own tobacco, and dissolvables Flavored (excluding menthol) cigarettes banned prior to this ban	*Sales:* • 86% decline in sales of flavored smokeless, cigars, pipe, and roll-your-own tobacco (p<0.000) • No statistically significant change in flavored or non-flavored smokeless tobacco sales, or overall sales of non-flavored smokeless, cigars, pipe, and roll-your-own tobacco *Youth behavior:* • 28% less likely to use any tobacco (OR 0.72: 95% CI 0.62 to 0.85) • 37% less likely to ever use flavored tobacco (OR 0.63: 95% CI 0.52 to 0.77). • No statistically significant change in current smoking (cigarettes, cigars, cigarillos) prevalence	*Sales:* 5% increase in sales of non-flavored cigars (p=0.003) 4% increase in sales of non-flavored pipe and roll-your-own tobacco (p = 0.03)	*Sales:* • Non-random subset of sales data from only stores with greater than 2 million in revenue (922 stores out of possible 9000+ stores) • Did not report changes in overall flavored and non-flavored tobacco products for products in study • Discuss results considering national sales trends, however do not perform quantitative analysis of comparison. • Sales data lacked assessment of hookah, cigarettes, and ENDS • Flavored products may have been missed if not in descriptor *Youth behavior:* • Only one timepoints pre- and post- ban for youth use, thus more of a pre-post cross-sectional study. • Behavior data lacked assessment of hookah, pipes, roll-your-own, and ENDS • Changes in the number of examples given in the 2013 question regarding use of flavored products that excluded examples of “blunts, chewing tobacco, snus, snuff, dip, or dissolvable tobacco pellets”	*Sales:* Demonstrates possible substitution of flavored cigars, smokeless tobacco, pipe, and roll-your-own tobacco. Provides evidence for regulatory compliance by stores. *Youth behavior:* Assessed 13-17 year specifically, with assessment of a more comprehensive ban on flavored products.
Nguyen and Grootendorst (2014)	Flavored (excluding menthol) cigarettes, cigarillos/little cigars (≤1.4g), and blunt wraps.	*Youth and Young Adults (15-24):* • 2.29 percentage point decline in past 30-day use of cigarillos (p<0.001) • 4.32 percentage point increase in 30-day abstinence from cigarillos (p<0.01) • 3.08 percentage point decline (p<0.001) in ever use of cigarillos • No statistically significant changes in *level* of ever use or past	*Youth and Young Adults:* • A change in *trend* of past 30-day use of cigars from -0.07 percentage points per month to an increase of 0.01 per month. • A change in *trend* of ever use of cigars from -0.17	Assessed 15-24 years of age as a group, which includes adults of legal age Represents combined impact of a ban on flavored products and a sales restriction minimum of 20 cigarillo units per pack. Does not distinguish between use of flavored and non-flavored regular cigar use	Presented data for a comparison group of 25-65 years Evaluation of cigarillo use level and trend showed most changes to cigarillo use occurred right after the policy rather than gradually.

And restriction on minimum cigarillos per pack (20 units)	30-day use of regular cigar use • 2.25 percentage point decline in ever use of all cigar types. • No changes in trends of use for cigarillos *Older Adults (25-65):* • No statistically significant changes in level or trends for cigarillo use • No statistically significant changes in the levels or trends of ever use of regular cigars or ever use of all cigar types. • Pre-policy trends for regular cigar ever-use, past 30-day use, and ever use of any cigar type were statistically significantly declining	per month to 0.05 per month. *Older Adults (25-65):* • A statistically significant decline in level of past 30-day use of regular cigars	Show that although there were no changes in *level* of use of cigars, there was a shift from a declining trend in cigar past 30-day use and ever use to a slightly positive trend post-ban. Overall, suggests that the decline in the use of cigarillos was sudden while the offsetting increases in the use of regular cigars was gradual

3.4.2 Changes in tobacco product sales

Table 5: Impact of flavor bans on sales generally

Reference	Flavored Products Banned	Percent decrease in tobacco use	Percent increase in other tobacco use or sales	Notable Limitations	Notable Strengths
Chaiton et al. (2018)	Flavored (excluding menthol) cigarettes and cigars (under 1.4 g, or with filter or non-spiral wrap)	*Sales:* • 49.6 million (95% CI −73.5 to −25.8) unit decline in overall sale of cigars • 59.2 million (95% CI 86.0 to 32.4) unit decline in flavored cigars *Sales trends:* • -6.9 million (95% CI −8.1 to −5.7) change in all cigar units per quarter from a previous slope of 4.9 (95% CI: 4.3 to 5.5) million all cigar units per quarter trend • -7.7 million (95% CI: -8.9 to -6.5) change in flavored cigars per quarter from a previous slope of 5.7 (95% CI: 5.0 to 6.5) million cigars per quarter.	*Sales:* • 9.6 million (95% CI −1.3 to 20.5) statistically non-significant increase in sales of non-flavored cigars • increase in the sales of brands with menthol and coffee descriptors, although this change was not examined statistically *Sales trends:* • 0.8 million (95% CI: 0.2-1.3) non-flavored cigars per quarter change in slope from -0.8 (-1.4 to -0.3) million per quarter pre-policy.	Possibly used the wrong date for *enforcement* of the ban, however conducted sensitivity analyses. Uses wholesale rather than retail data, which may limit knowledge of smaller provinces who may purchase from larger provinces instead of buying wholesale.	Sensitivity analyses changing date of intervention changed to one year prior and after the first quarter of 2010 that showed findings insensitive to later dates and sensitive to earlier dates. Sensitivity analyses comparing province with substantial prior regulation (Ontario) and one without (British Columbia) that showed large and similar post-intervention changes in each despite different baseline levels. This suggests effects driven by federal regulation rather than any individual province Commented and graphed an increase in sales of brands with color descriptors but no flavor descriptors, however they did not provide the quantitative estimates. Controls for time trends by adjusting for seasonal and autocorrelation effects**. They found seasonal effects.** Differentiates flavored and non-flavored cigar products Assesses unit sales rather than dollar sales.
Delnevo and Hrywna (2015)	Flavored (excluding menthol) cigarettes	*Sales* Not reported *Import volume* Clove cigarette sticks declined to zero in 2010 from 532 million in 2008	*Sales* 1454.1% increase in clove cigar sticks from about 5.3 million in 2009 to over 82.8 million in 2012 748.60% increase in clove cigar sticks from about 5.3 million in 2009 to about 39.9 million in 2010. *Import Volume* Cigar sticks increased to about 656 million in 2010 from 2.4 million in 2008	Effects are large, but no quantitative analysis is done of changes Could not review all internal documents given to congress. Limited to only one retail channel -- convenience stores Import data does not specify clove cigars, but prior to flavor cigarette ban Indonesia produced a small volume of cigars	Assessed tobacco industry decision making in response to possible ban. **Sales data representative of all US convenience stores – the largest retail channel for cigars.** Provided evidence for substitution of clove cigarettes with clove cigars
Jo et al. (2015)	Flavored (excluding	*Availability compared to 2009* • 36% (OR 0.64, 95% CI: 0.42–0.96)	*Availability compared to 2009*	Potential misclassification of physical location of online vendors given that different components may be in different	Only study showing post-ban changes in online vendors

	menthol) cigarettes	decrease in selling flavored cigarettes in 2010 • No statistically significant results for changes in clove cigarette availability in 2010 or 2011 • No statistically significant results for changes in flavored cigarette or flavored little cigar availability in 2011	• 450% (OR 5.5, 95% CI: 2.36-12.80) clove cigars in 2010 • 385% (OR 4.85, 95% CI: 2.08–11.31) clove cigars in 2011 • 71% (OR 1.71, 95% CI: 1.09-2.69) flavored little cigars in 2010) *Noncompliance in 2011* • 28.6% of US vendors sold flavored cigarettes • 2.9% of US vendors sold clove cigarettes.	locations (e.g. stated address, order processing, web hosting, order fulfillment) Study notes changes in product availability and not actual product sales Study only does chi-squared analysis and no analysis on overall change in level or trend of product availability. However, chi-square suggests there would be no change for flavored cigarettes and little cigars.	Provide evidence for substitution of clove cigarettes with clove cigars Provide evidence of non-compliance by some online vendors
Farley and Johns (2017)	Flavored (excluding menthol) cigars, cigarillos, little cigars, chew, snuff, snus, pipe tobacco, roll-your-own tobacco, and dissolvables Flavored (excluding menthol) cigarettes banned prior to this ban	*Sales:* • 86% decline in sales of flavored smokeless, cigars, pipe, and roll-your-own tobacco (p<0.000) • 86.2% (p<0.000) decline in flavored cigars • 91.1% (p<0.000) decline in flavored pipe and roll-your-own tobacco. • No statistically significant change in flavored or non-flavored smokeless tobacco sales, or overall sales of non-flavored smokeless, cigars, pipe, and roll-your-own tobacco *Post-ban sales trends in product per 4-week period:* • No statistically significant sales trends for any flavored product • -5294.00 (p<0.000) overall non-flavored products • -3295.00 (p<0.000) non-flavored cigars • -758.22 (p<0.004) non-flavored smokeless tobacco • -1458.00 (p<0.000) non-flavored pipe and roll-your-own tobacco	*Sales:* 5% increase in sales of non-flavored cigars (p=0.003) 4% increase in sales of non-flavored pipe and roll-your-own tobacco (p = 0.03)	*Sales:* • Non-random subset of sales data from only stores with greater than 2 million in revenue (922 stores out of possible 9000+ stores) • Did not report changes in overall flavored and non-flavored tobacco products for products in study • Discuss results considering national sales trends, however do not perform quantitative analysis of comparison. • Sales data lacked assessment of hookah, cigarettes, and ENDS • Flavored products may have been missed if not in descriptor *Youth behavior:* • Only one timepoints pre- and post- ban for youth use, thus more of a pre-post cross-sectional study. • Behavior data lacked assessment of hookah, pipes, roll-your-own, and ENDS • Changes in the number of examples given in the 2013 question regarding use of flavored products that excluded examples of “blunts, chewing tobacco, snus, snuff, dip, or dissolvable tobacco pellets”	*Sales:* Demonstrates possible substitution of flavored cigars, smokeless tobacco, pipe, and roll-your-own tobacco. Provides evidence for regulatory compliance by stores. *Youth behavior:* Assessed 13-17 year specifically, with assessment of a more comprehensive ban on flavored products.
Rogers et al. (2017)	Flavored (excluding menthol), cigars, pipe tobacco, smokeless tobacco	*NYC average sales:* • 7.4% (p<0.01) decline in average sales of all cigars • No statistically significant change in trends of all cigar sales • 31.8% (p<0.01) decline in all flavored products	*Comparison area average sales:* • 9.8% increase in average sales of all cigars • Negative change in trend (p<0.05) of all cigar sales	Did not report actual change in slope but only the direction of the change. Look at immediate drops and average drops in sales levels post-intervention. I report changes in the averages, while the authors focus on the immediate levels pre- and post-intervention.	Followed up on ambiguous flavor descriptors (i.e. "concept flavors" like "blue haze") The use of comparison areas, strengthens the case for policy attribution for effect The use of a close proximal area allowed consideration of cross-border purchasing.

[SLT], dissolvable tobacco, snuff, shisha, blunts, and blunt wraps.	• 25.5% (p<0.01) decline in flavored cigars • 97.6% (p<0.01) decline in flavored smokeless tobacco • 78.1% (p<0.01) decline in flavored roll-your-own *Comparison area average sales:* • 7.8% (p<0.05) decline in flavored smokeless tobacco • 33.2% (p<0.01) decline in flavored roll-your-own *United States:* • 18.4% (p<0.05) decline in flavored smokeless tobacco • 31.9% (p<0.01) decline in flavored roll-your-own	• 2.2% (p<0.05) increase in all flavored products • 3.2% (p<0.01) increase in flavored cigars *United States average sales:* • statistically non-significant 12%increase in sales of all cigars • No statistically significant change in trends of all cigar sales • 10.9 (p<0.01) increase in all flavored products • 14.6% (p<0.01) increase in flavored cigars	Sales data not available from about 57% of licensed tobacco retailers due to exclusion of smaller groceries (revenue<$2 million), convenience and drug stores (revenue<$1 million), and corner stores and bodegas Cannot use data to explain why policy did not eliminate flavored cigar sales completely, but posit a lack of awareness of the policy by some retailers; intentional violation of the policy by some retailers; and increasing availability of cigars with ambiguous flavor descriptions (e.g., “purple” instead of “grape”), which could serve to circumvent policy enforcement. The observed changes in retail sales could reflect change in how NYC consumers purchase products (e.g. online) The pre-policy period is relatively short and may not depict the trend in flavored product sales accurately	Larger sample of retailers as compared Farley and Johns (2017) Regression control for serial correlation and heteroskedasticity

3.5 Discussion

3.5.1 Changes in youth use of products

The three studies (Courtemanche et al. 2017; Farley and Johns 2017; Nguyen and Grootendorst 2015) each assessed the impact of policies banning different flavored tobacco products on tobacco use by youth and young adults. Each study found a statistically significant association between the post-ban time period and reductions in tobacco use using representative samples of their population of interest. Two studies (Courtemanche et al. 2017; Farley and Johns 2017) found decreases in odds of using any tobacco, while one study that focused solely on cigarillos and cigars found a decrease in ever use of all cigar types driven by a decline in cigarillo usage. However, each study found some evidence of substitution of banned flavored products with other tobacco products. In response to a flavored (excluding menthol) cigarette ban, Courtemanche et al. (2017) found increases in use of menthol cigarettes and non-cigarette tobacco products by individuals 11-19 years of age. In response to a more comprehensive flavored tobacco ban, Farley and Johns (2017) reported increases in sales of non-flavored cigars, pipe, and roll-your-own tobacco, although their pre- and post- surveys on individuals 13-17 years of age found no indication of increases in smoking prevalence. Lastly, in response to a flavored cigarillo ban, Nguyen and Grootendorst (2015) found evidence of a change in the decreasing trend of regular cigar ever use and past 30-day use to a modestly increasing trend of use by individuals 15-24 years of age. Additionally, Nguyen and Grootendorst (2015) is the only study with a comparison group of older adults (25-65 years of age) showing a differential impact on older adults who experienced no significant changes in use except for a minor 0.37 percentage point decrease in past 30-day use of regular cigars. This provides evidence for flavor playing a different role in use behavior for older adults among this subset of studies that is echoed across other study types and reviews. Drawing inferences for solely youth on this subset of studies is limited as only Farley and Johns (2017) obtain use behavior from exclusively legal minors. However, the data suggests that previous flavor bans have an association with decreased overall use of tobacco products among youth and young adults paired with relatively smaller increases (Courtemanche et al. 2017), no discernable increases among youth (Farley and Johns et al. 2017), or gradual increases (Nguyen and Grootendorst) in use of other tobacco products.

Limitations for studies on youth and young adult behavior use following a flavor ban include lack of a comparison area, variable controlling for time trends between studies, and accounting for whether substitution products were flavored or non-flavored. No studies had a comparison area to better control for secular trends unrelated to the policy intervention. Inclusion of a comparison area could have strengthened the case for attribution, however finding an adequate comparison area for the United States or Canada may have proved difficult. Lacking a comparison area, each study attempted to control for secular time trends in a variable way with unknown adequacy. Courtemanche et al. (2017) used a quadratic time trend control, Nguyen and Grootendorst (2014) controlled only for season, and Farley and Johns (2017) used a continuous four-week time-period indicator variable. Lastly, only Farley and Johns (2017) had data differentiating flavored and non-flavored non-cigarette products to help discern whether flavor availability in other products is driving post-ban substitution. The other two studies (Courtemanche et al. 2017; Nguyen and Grootendorst 2014) who assessed bans on certain flavored tobacco products only hypothesize that the increased use in the unbanned products is driven by flavor availability in the other products.

3.5.2 Changes in tobacco product sales

Although each study assessed different groups of tobacco products, they each showed some evidence of expected declines to flavored products paired with some increase (not always statistically significant) in a related tobacco product. In Canada, Chaiton et al. (2018) reported decreases in the overall sales of cigars driven by declines in flavored cigar sales despite statistically non-significant increases in non-flavored cigar sales. In a U.S. study focused on clove-flavored products, Delnevo and Hrywna (2015) reported a decline in the import of clove cigarettes to zero, but a 748.60% increase in the sales of clove *cigars* the year after the ban. In a different U.S. study focused on online availability, Jo et al. (2015) reported inconsistent changes to the availability of flavored cigarettes and little cigars, but a sustained increase in the availability of clove cigars from U.S-based online vendors. Two studies (Farley and Johns 2017; Rogers et al. 2017) focused on flavored and non-flavored smokeless tobacco, cigars, pipe, and roll-your-own tobacco in New York City using slightly different study designs and data sources. Farley and Johns (2017) reported expected declines in overall flavored products driven by declines in flavored cigars, pipe, and roll-your-own tobacco, but paired with increases in sales of non-flavored cigars, pipe, and roll-your-own tobacco. Rogers et al. (2017) reported declines in average sales of all (flavored and non-flavored) cigars, all flavored products, and for each flavored product. Rogers et al. (2017) contrasted these results to increases in sales of flavored cigars and all (flavored and non-flavored) cigars in a geographically proximal area and the United States. Notably, increases in sales of all cigars was not statistically significant in the United States. Importantly, only two studies (Chaiton et al. 2018; Rogers et al. 2017), explored and provided evidence for the effects of flavored product declines on a related decrease in sales of that overall tobacco product category.

Each study also reported trends differently with variation in focus on trend changes or the post-policy trend. Chaiton et al. (2018) report only trend changes for flavored and non-flavored cigars, Farley and Johns (2017) report only post-policy trends for flavored and non-flavored products, and Rogers et al. (2017) report post-policy trends and trend changes but for flavored products only. The two studies (Chaiton et al. 2018; Rogers et al. 2017) examining trend changes in flavored products show inconsistent results. Chaiton et al. (2018) report a substantial negative trend change in flavored cigars, but Rogers et al. did not find a statistically significant change for flavored cigars. Additionally, Rogers et al. (2017) report a significant negative trend change for only flavored smokeless tobacco products, but there is not a corresponding negative post-policy trend for this product. The two studies (Farley and Johns 2017; Rogers et al. 2017) examining post-policy sales trends of flavored products generally show a lack of statistical significance but are inconsistent regarding flavored roll-your-own tobacco. Farley and Johns (2017) did not find any statistically significant post-ban sales trends for any flavored products that included assessment of a combined flavored pipe and roll-your-own tobacco category. On the other hand, Rogers et al. (2017 found a negative post-policy trend for flavored roll-your-own tobacco. Rogers et al. (2017) did not report a corresponding significant trend change. This discrepancy may be due to the use of a combined pipe and roll-your-own reporting group in Farley and Johns (2017) or other study design choices. The evidence does not support an association of flavored product bans with significant trend changes or post-policy trends for flavored products. This may be due to the already large drop in sales but may also reflect the need for a longer post-policy surveillance period.

Two studies (Chaiton et al. 2018; Farley and Johns 2017) assessed the impact of flavored product bans on trend changes or post-policy trends for non-flavored products. Chaiton et al. (2018) are the only study to report trend changes in non-flavored products, while Farley and Johns (2017) are the

only study to report post-ban sales trends for non-flavored products. Chaiton et al. (2018) report a modest positive trend change in sales of non-flavored cigars, while Farley and Johns (2017) report negative post-ban sales trends for non-flavored products overall, non-flavored cigars, non-flavored smokeless tobacco, and non-flavored pipe and roll-your-own tobacco. This limited set of evidence suggest the flavor ban was associated with a positive trend change in non-flavored cigar, but that the post-ban trend of non-flavored cigars remained negative.

Five studies evaluated changes in trends and levels of sales in response to the 2010 Canadian ban (Chaiton et al. 2018), 2010 NYC ban (Farley and Johns 2017; Rogers et al. 2017), or 2009 US FDA ban on flavored cigarettes (Delnevo and Hrywna 2015; Jo et al. 2015). Although each study assessed different groups of tobacco products, they each showed some evidence of expected declines to flavored products paired with some increase (not always statistically significant) in sales or trends of a related tobacco product. This shows evidence of timely compliance – excepting online vendors – with regulation and some immediate possible product substitution. The evidence does not support an association of flavored product bans with significant trend changes or post-policy trends for flavored products, however a limited subset of evidence suggests the flavor ban was associated with a positive trend change in non-flavored cigars, but that the post-ban trend of non-flavored cigars remained negative. This limited evidence suggests flavor bans could lead to gradual declines in use of non-flavored products.

Limitations for studies on tobacco sales following a flavor ban include studies with generally non-representative or unclear samples, inconsistent selection of tobacco products evaluated/reported, variable control for time trends, general absence of comparison areas, and inconsistent consideration of ambiguous/color product descriptors. Included studies had non-representative or unclear samples of data except for Delnevo and Hrywna (2015) who used a representative sample of convenience stores. Studies assessed different tobacco product types and attributes and although discussion focused on similarities and differences between studies, comparability between studies was limited. The three studies (Chaiton et al. 2018; Farley and Johns 2017; Rogers et al. 2017) that assessed sale trends controlled for secular time trends differently with Farley and Johns (2017) failing to report control for auto-correlation/serial correlation, and only Chaiton et al. (2018) reporting control for seasonality. Only two studies (Chaiton et al. 2018; Rogers et al. 2017) attempt to compare observed trends to another areas – a comparison that better control for secular trends and strengthens the case for policy impact. Lastly, only two (Chaiton et al. 2018; Rogers et al. 2017) considered the role of ambiguous product descriptors or color – each recognized to connote flavor – but neither report associated quantitative estimates in change.

3.5.3 General Limitations

Generally, studies using interrupted time series analysis are subject to lack of accounting for any secular trends or outside interventions that may result in the observed changes. Studies of these types can suffer from ecological bias and only add to associative non-causal evidence. These limitations can be mitigated by including a control group, which strengthens the case for attribution to the flavor ban intervention. Additionally, continuous data can help note abrupt changes in the trends or levels of sales or tobacco use, however this was only available for sales-oriented data, since youth use data relied on periodic surveys.

The subset of youth use behavior studies would better benefit policy formation if it consistently assessed youth as distinct from adults and compared the impact of flavors on product selection between youth and adult smokers. Two studies (Courtemanche et al 2017; Nguyen and Grootendorst 2015) used a study population that overlapped with adults of legal age and only one (Nguyen and Grootendorst 2015) of these compared results of older adults to the younger group.

Sales data is generally limited as it cannot account for black market sales and only one available study used a representative sample. Sales data also paints a general picture of the effect of flavor bans and not the impact on the population of interest. Youth tobacco use likely only modestly influences the sales data (Farley and Johns 2017).

Other limitations related to study design include accounting for the various tobacco products available and poor labeling regulation. Tobacco product substitution has been highlighted as a particularly important consequence of tobacco regulation, but the multitude of products available make assessing substitution and reasons behind it complex, especially considering other products vary in price, design, nicotine content, and various other attributes. Additionally, other studies have noted that the quality of labeling is low and does not adequately reflect ingredients or flavor additives. Tobacco companies could and have changed its packaging to ambiguous descriptors (e.g. Smooth Blue) and products exist that have been changed to have mixtures of flavor additives that are not "characterizing." Tobacco companies could and have also slightly changed their flavored products to meet a different product standard that allows flavors (e.g. Kretek international's creation of clove cigars"). Despite these issues, impacts of the regulation were seen across included studies.

3.6 Conclusion

The ecological nature of data prevents causal inference especially considering the lack of comparison areas in all youth use behavior studies and in only two sales-related studies. Nevertheless, the data on youth-use behavior provides supporting evidence for an association of flavor bans with declining use in youth and young adults and the sales data provides support for compliance, decreases in overall use, and possible tobacco product substitution.

4. DISCRETE CHOICE EXPERIMENTS

4.1 Introduction

Discrete choice experiments (DCEs) are an established marketing and microeconomic methodology that allows simultaneous testing of the influence of product characteristics. Respondents are given various sets of hypothetical situations in which they must choose between several alternatives. This methodology has been increasingly used in tobacco research in recent years (Regmi et al. 2017). DCEs allow comparison of the relative importance of different product attributes on the final decision to use a product. They also allow assessing interactions of product characteristics on selection of tobacco products. They have also been used to hypothesize the quantitative impact of alternative policies that are currently not in place (Buckell et al. 2018). DCEs are generally limited by measuring a stated preference rather than a substitute for actual behavior. However, other studies have shown comparability between experimental and real-world behaviors for tobacco (Few et al. 2012; Wilson et al. 2015). DCE tobacco studies have been reviewed previously (Regmi et al. 2017), but the previous review did not focus on DCEs focusing on flavor preferences and lacked half of the studies included here.

4.2 Methods

Studies were originally identified based on a literature search on policy bans, but this category of experiments had not previously been examined. Each study was reviewed and summarized below. Study results were then synthesized into trends. Discussion of studies respectively used the terms "youth", "young adult", "older adult", and "adults" to refer to those<18 years of age, 18-25 years of age, > 25 years of age, and >18+. Studies do not always use populations that fall neatly into these categories and ages will be specified when this occurs. Studies that looked at only adults were included to contrast results with those of youth. Additionally, the term "flavor" is used to refer specifically to non-tobacco flavors including menthol.

Discrete choice experiments were not the focus of the original systematic search but noted as an important subset of search results that have not previously been discussed. Retrospectively, a new search was conducted in PubMed of the query in the table below. No other relevant studies were identified after abstract review. Based on abstracts: five studies were moved to full article review. An abstraction table of the study results is included in Appendix C.

Table 6: Databases and Proposed Search Queries for Discrete Choice Experiments

Database	**Search Query**	**Notes**
PubMed	(Experiment*) AND ("Flavoring Agents"[Mesh] OR flavor* OR flavour*) AND (tobacco OR cigarette OR smok* OR ENDS OR snuff OR snus OR e-cig* OR "potential reduced exposure products" OR nicotine OR PREP)	180 results (1/22/18)

4.3 Literature Summaries

Buckell et al. (2018) examined the impact of flavors, prices, nicotine content, and health on adult smokers' and recent quitters' selection of hypothetical cigarette or e-cigarette products. They used a sample of 2,031 US adult smokers and recent quitters aged 18-64 recruited through the survey firm Qualtrics using quotas to match the proportions of smokers in the 2014 Behavioral risk Factor Surveillance system. Each participant was presented 36 sets of choices between two e-cigarette products, two cigarette products, and an option for none of the products. The participant could mark their first and second preference. There were 256 possible e-cigarette products and 24 possible cigarette products that varied flavors, life years lost warnings, nicotine levels, and price. They found that overall, current smokers and recent quitters prefer cigarettes and menthol cigarettes over flavored e-cigarettes. However, they noted younger adult (18-25 years) preferred any flavored e-cigarettes, while older adult smokers preferred tobacco cigarettes. They uniquely used their findings to evaluate the impact of alternative flavor bans. They found a ban on menthol cigarettes would produce the greatest reduction in choice of cigarettes (-5.2%), but with a 3.8% increase in e-cigarette use. A ban on flavored e-cigarettes would result in greatest increase in choice of cigarette (8.3%), and an 11.1% decrease in e-cigarette use. A ban on all flavors would increase 'opting-out' the most (5.2%) but would increase choice of cigarettes (2.7%) and decrease choice of e-cigarettes (-7.9). The study was strengthened by a broad range of robustness checks and sensitivity analyses, however, it had some notable limitations. Their predictive model lacked an ability to discern changes in dual use, and the authors hypothesized that a proportion of e-cigarette users included dual users. Their use of two preferences in their choice modeling make this a slightly different methodology than the other four studies, but should not impact interpretability.

Shang et al. (2018) examined the simultaneous impact and relative effects of flavor, device type, and health warning messages on youth selection of hypothetical ENDS products. They used a representative sample of 515 individuals aged 14-17 recruited through random digit dialing. This sample contained 50 ever users and 465 never users of ENDS. Each participant was presented nine sets of choices comprised of an opt-out option and two hypothetical ENDS products. Ever users were given an additional option of opting out in favor of their most used ENDS products. There were 24 possible ENDS products to choose from varying design, flavor, and warning messages. The two designs were a cigarette-like e-cigarette and a modifiable product (e-go/mods/APVs). The three flavors were tobacco, menthol, and fruits/sweets/beverage. Lastly the four potential warnings were none, FDA proposed warning, FDA CTP warning, and the MarkTen warning. Among ever users, no attribute was statistically significant at a 95% confidence level, however they report a statistically non-significant increase in likelihood of choosing flavored products ($p<0.1$), particularly fruit/sweets/beverage ($p<0.1$). Among never users, there was a statistically significant increase in selection of ENDS products that were flavored with fruits/sweets/beverage ($p<0.01$) or menthol ($p<0.05$) compared to tobacco flavor. A comparison among attributes indicates that among never-users: fruit/sweet/beverage flavor has the largest impact on ENDS choices, followed by menthol flavor, FDA-CTP/MarkTen warning messages, and modifiable devices. The additional attributes assessed pointed to increases in ENDS selection for modifiable products and decreases in selection with FDA CTP or MarkTen warning statements. This study notably lacked inclusion of price, however the effects of increased price are generally well accepted.

Czoli et al. (2016) examined the impact and relative effects of flavor, nicotine content, health warnings, and price on selection of e-cigarettes. They used a convenience sample of 915 Canadians

consisting of 279 non-smoking youth and young adults of 16-24 years of age, 264 smoking youth and young adults of 16-24 years of age, and 372 smoking adults of at least 25 years of age. Each participant selected a product regarding intention to try, product harm, and quit efficacy for 20 sets of choices comprised of four products and a none of the above option. There were 128 possible products varying flavor, nicotine content, health warnings, and prices. There were four flavor options of tobacco, menthol, coffee, or cherry. There were four nicotine content options of none, low (6-8), medium (10-12), and high (16). There were four possible health warning options of none, the existing Health Canada warning, a proposed EU warning, and a comprehensive proposed EU warning. There were two possible prices of low ($7.99) and high ($9.99). In terms of intention to try, younger non-smokers showed interest in non-tobacco flavored products, while older smokers had greater interest in trying tobacco-flavored products. Young smokers expressed a significant preference for cherry flavored e-cigarettes. Notable limitations of this study include the use of a convenience sample and that the study was conducted in Canada. Canada prohibits e-cigarettes containing nicotine, although they are widely available as 9% of Canadians aged 15 years and older have ever tried an e-cigarette in 2013. The study was notably well-designed with randomized choice sets randomized product order, and pilot tested questions.

Pesko et al. (2016) estimated the effect of prices, flavor availability, and warning labels on the selection of ENDS with a national sample of 1,200 US adult smokers. Each participant was randomly assigned one of ten surveys that each contained 12 sets of four choices. They could choose between their preferred brand and pack, nicotine replacement therapy pack, a "disposable vaping device", or proceed without selecting an item. There were 24 possible "disposable vaping device" products varying price ($3, $6, or $9), flavors (regular/menthol or cove, spice, candy, fruit, chocolate, alcohol, sweets), or warnings (none, proposed FDA warning, proposed MRTP warning, and the MarkTen warning). After adjustment, young adult smokers (18-24 years of age) were 3.7 percentage points (95% CI: 2.0-5.5) more likely to choose ENDS when multiple flavors were available compared to older adults ($p<0.001$). Overall, after adjustment, increased flavor availability in ENDS was associated with a 2.1 percentage point increase in ENDS ($p<0.001$). Increased prices had the expected inverse relationship with ENDS selection. Additionally, respondents were overall 2.4% (95% CI: 1.0-3.8) less likely to choose ENDS with the MarkTen warning label ($p<0.001$). There was no associated reduction in ENDS selection using the MRTP and proposed FDA warning label compared to no warning. This study adjusted for many possible confounders, however had some notable limitations. Unlike other DCEs, this study grouped tobacco and menthol flavors, while giving a general group for non-tobacco flavors. This lost some realism to the decision but does mimic the current policy landscape. Additionally, this study only gave the option of disposable ENDS products rather than considering non-disposable products. Device type has been shown to influence use in other studies, and a post-DCE survey showed that 9% of respondents would have been "much more likely" to choose the vaping device if it had been refillable.

Salloum et al. (2015) assessed the impact of price, flavor, nicotine content, and health warnings on selection of waterpipe smoking products. They used a convenience sample of 367 adults attending a southeastern university. Each participant was given a set of nine different choices randomized to include an FDA recommended warning. Each set of choices consisted of three fruit-flavors, one tobacco flavor, and an opt-out option. Additionally, the products could vary in price ($5, $10, $20) and nicotine content (Nicotine-free, 0.05%, 0.5%). Overall, there was a preference for fruit-flavor to tobacco flavor, lower nicotine, and more likely to opt out if there was a health warning. Compared to the average user,

tobacco flavor was associated with 78% lower odds of selection. Pirate's cave, Blue Mist, and Double Apple had 2.41, 3.09, 3.81 times the odds of selection compared to tobacco flavor controlling for nicotine content, price, and opt-out choices. Regarding the relative importance of attributes, they reported that “flavour accounted for almost two-thirds (65%) of the waterpipe smoking decision, followed by price (22%) and nicotine content (13%)”. Additionally, they found heterogeneity in selection preferences as females and non-cigarette smokers were more likely than their “counterparts to prefer flavoured and nicotine-free varieties.” The assessment of a tobacco product aside from ENDS was notably unique as was the use of a hookah menu to obtain choices. Notable limitations included the use of a convenience sample that did not vary time of day or location of sampling, as well as a lack of random ordering of tobacco product options within each set of choices.

4.4 Summary Table

Table 7: Discrete Choice Experiment Results

Reference	Discrete Choices	Results (Statistically significant unless noted otherwise)	Notable Limitations	Notable Strengths
Buckell et al. (2018)	36 choice sets of: Two e-cigarette products, Two cigarette products, and None 256 possible e-cigarette products and 24 possible cigarette products that varied: **Flavors**: tobacco, menthol, fruit (e), sweet (e) **Life years lost by average use**r: 10, 5 (e), 2 (e), Unknown (e) **Level of nicotine:** High, Medium, Low, None (e) **Price:** $4.99, %7.99, $10.99, $13.99 *Variations of attributes only available for e-cigarette products marked (e)	**Overall:** Current smokers and recent quitters prefer cigarettes and menthol cigarettes over flavored e-cigarettes. **Younger adults (18-25):** Younger adult smokers prefer menthol cigarettes and all flavoured (including tobacco) *e-cigarettes* **Older adults (26-64):** Older adult smokers prefer tobacco cigarettes. **Policy predictions:** • Menthol cigarette ban would produce the greatest reduction in choice of cigarettes (-5.2%), but with 3.8% increase in e-cigarette use. • Flavored e-cigarette ban would result in greatest increase in choice of cigarette (8.3%), and an 11.1% decrease in e-cigarette use. • A ban on all flavors would increase 'opting-out' the most (5.2%), but would increase choice of cigarettes (2.7%) and decrease choice of e-cigarettes (-7.9)	Policy predictions do not account for dual users. They report that some proportion of e-cigarette users would be dual users. Option of "none" may either indicate quitting or indicate no desire for the listed products. Did not use quantitative levels of nicotine (e.g., in mg) Did not offer these smokers an option for their own product. Possible limited comparability to other DCE studies by allowing selection of first and second preference Did not give relative importance of attributes	Only study that compares impacts of policy alternatives and substitution effects between products Detailed description and visual describing hypothetical products given prior to the DCE Broad range of quality checks: • Sample practice experiment task given to give respondents practice. • Prevented respondents from skipping through the survey. • Minimum time threshold to remove respondents who rushed through. • Questions in the survey to check that respondents were paying attention
Czoli et al. (2016)	20 choice sets of: 4 ENDS products, and None of the above 128 possible products that varied: **Flavors:** tobacco, menthol, coffee, cherry **Nicotine content**s: None (0), Low (6-8), Medium (10-12), High (16) **Health warning**s: None, Health Canada warning, EC1, EC2 P**rices**: Low ($7.99) or High ($9.99) *For each choice set the participant selected the product they intended to try, the product they perceived as less harmful, and the product they perceived that enhanced quit efficacy	**Overall,** there was more interest in trying e-cigarettes with cherry (p<0.0001) and menthol (p=0.01) flavors. Menthol (p<0.0001) and coffee flavors (p<0.0001) were perceived as less harmful and as having greater quit efficacy. **Younger (16-24) non-smokers** showed interest in trying various e-cigarette flavors, including coffee (p<0.01), cherry (p<0.0001) and menthol (p<0.001). They were more likely to perceive coffee-flavoured (p=0.02) e-cigarettes as less harmful and as having greater quit efficacy (p=0.01), **Younger (16-24) smokers** expressed an interest in trying products with cherry flavour (p<0.001), perceived cherry flavor as less harmful (p=0.02), and considered cherry flavor to have greater quit efficacy (p=0.02) **Older (25+) smokers** indicated greater interest in trying tobacco-flavoured products (p<0.0001), They perceived tobacco-flavored products as less harmful (p<0.001), and as increasing quit efficacy (p<0.0001) **Relative importance of attributes:** • Health warnings, flavor, price, and nicotine respectively accounted for 42%, 24%, 19%, and 15% of consumer intentions to try e-cigarettes. • Health warnings, flavor, price, and nicotine respectively accounted for 35%, 36%, 14%, and 15% of perceptions of reduced product harm • Health warnings, flavor, price, and nicotine respectively accounted for 39%, 25%, 26%, and 10% of perceptions of enhanced product quit efficacy	Convenience sample Does not account for branding and marketing Study conducted in Canada, where e-cigarettes containing nicotine are prohibited.	Pilot tested questions Assessed three related, but important outcomes Assessed adults and youth by demonstrating heterogeneity of product selection Used quantitative and qualitative descriptors of nicotine
Pesko et al. (2016)	12 choice sets of: Their preferred brand and pack, NRT priced at $6, Disposable vaping device with varying price, flavor, and warning Proceed without selecting, 24 possible vaping devices varying: **Price:** $3, $6, $9 **Flavor Availability:** regular/menthol or "many flavors" **Warnings:** no warning, proposed FDA warning, modified risk statement by RJ Reynolds and Swedish Match, and	**Overall**, increased flavor availability in ENDS was associated with a 2.1 percentage point increase in ENDS (p<0.001) after adjustment. **Young adult smokers (18-24):** Prior to adjustment, selected more ENDS products with increased flavor availability, from 17.5% to 21.9% (p<0.001), but there was no statistically significant increase for older adults (25+). After adjustment, young adult smokers were 3.7 percentage points (95% CI: 2.0-5.5) more likely to choose ENDS when multiple flavors were available compared to older adults (p<0.001). **Non-vapers (in the past month):** Prior to adjustment, increased flavor availability was associated with ENDS selection from 9.6 % to 11.5% (p<0.01). After adjustment this did not hold. **Prices:** Had an inverse relationship to ENDS selection. Price increases from $3 to $6 was associated with a 13.6 percentage point reduction (p<0.001) **Warnings:** After adjustment, respondents were overall 2.4% (95% CI: 1.0-3.8) percentage points less likely to choose ENDS with the MarkTen warning label (p<0.001). No associated reduction in ENDS selection using the MRTPA and proposed FDA warning label compared to no warning.	No differentiation between tobacco/menthol and "many flavors" option Choice of "many flavors" does not mimic a real-world choice of tobacco and a product with a single flavor. Uses disposable products rather non-disposable products No none of the above option, but rather to proceed without selecting	Adjusts for multiple features

	MarkTen warning		Did not give relative importance of attributes	
Salloum et al. (2015)	9 choice sets of: Three fruit-flavors, One tobacco option, Opt-out option. 36 potential products: **Flavor:** Double Apple, Blue Mist, Pirate's Cave, Tobacco Flavor **Nicotine content:** Nicotine-free, 0.05%, 0.5% **Price:** $5, $10, $20 Additionally, each individual randomized to receive choices that included a health warning or not. The warning was the FDA recommended warning for cigarettes modified for waterpipes	**Overall**, college waterpipe smokers selected fruit-flavored, lower nicotine products without health warnings. Compared to the average user, tobacco flavor was associated with 78% lower odds of selection. Pirate's cave, Blue Mist, and Double Apple had 2.41, 3.09, 3.81 times the odds of selection compared to tobacco flavor controlling for nicotine content, price, and opt-out choices. **Females and non-cigarette smokers:** "more likely than their counterparts to prefer flavoured and nicotine-free varieties." **Relative importance of attributes:** "flavour accounted for almost two-thirds (65%) of the waterpipe smoking decision, followed by price (22%) and nicotine content (13%)".	Convenience sample with no attempt to vary time of day or day or location in sampling Did not include random ordering of flavor options within each set Used only quantitative representations of nicotine	Assesses a tobacco product aside from ENDS Attributes chosen based on prior studies document current waterpipe tobacco packages Heterogeneity in preferences by gender and cigarette smoking status. Product menus to emulate real-world experience
Shang et al. (2018)	9 choice sets of: Two ENDS alternatives, opt-out completely, and opt-out in favor of their most used ENDS product (for ever users only) 24 possible ENDS products: **Flavor:** Tobacco, Menthol, or Fruits/Sweets/beverage **Designs**: Cigarette-like e-cigarette or Modifiable product (e-go/Mods/APVs) **Warnings**: None, FDA proposed warning, FDA CTP warning, and MarkTen warning	**Among ever users:** no attribute was statistically significant at a 95% confidence level, however they report a statistically non-significant increase in likelihood of choosing flavored products ($p<0.1$), particularly fruit/sweets/beverage ($p<0.1$). **Among never users:** • There was a statistically significant increase in selection of ENDS products that were flavored with fruits/sweets/beverage ($p<0.01$) or menthol ($p<0.05$) compared to tobacco flavor. • Vaping devices that are modifiable, compared with cigarette-like e-cigarettes, increase ($p<0.05$) the probability of choosing ENDS among adolescent never-users. • Warning messages reduce ($p<0.01$) the probability of choosing ENDS. The FDA CTP statement and MarkTen warning messages significantly decrease the probability of choosing ends compared to the proposed FDA statement ($p<0.01$) **Relative importance among never-users:** fruit/sweet/beverage flavor has the largest impact on ENDS choices, followed by menthol flavor, FDA-CTP/MarkTen warning messages, and modifiable devices.	Did not assess prices	Noted heterogeneity among adolescent never-users and ever-users Detailed methods and robustness checks Sample size chosen explicitly to detect at effect size of 0.1 with 80% power at 95% confidence level Checked consistency of results, by dropping the 10% participants who completed the experiment in 8 minutes

4.5 Discussion

4.5.1 Youth-focused studies on ENDS

Two DCE studies (Czoli et al. 2016; Shang et al. 2018) included youth in their study and showed increased selection of non-tobacco flavored products among youth non-smokers. Shang et al. (2018) studied only adolescent (14-17) never-ENDS users and ever-ENDS users. Ever users of ENDS did not experience any statistically significant impact of flavor, designs, or warnings on selection of ENDS products, however never users had increased selection of ENDS flavored with fruits/sweets/beverage ($p<0.01$) or menthol ($p<0.05$) compared to tobacco flavor. Among never users, fruit/sweet/beverage flavor had the largest impact on ENDS choices, followed by menthol flavor, FDA-CTP/MarkTen warning messages, and modifiable devices. Czoli et al. (2016) also reported statistically significant increased selection of flavored products albeit for a combined group of youth and young adults (16-24). They also considered heterogeneity in preferences between smokers and non-smokers, but in contrast with Shang et al. (2018) the group with youth smokers distinctly selected cherry-flavored products ($p<0.001$) rather than have no preference. The results for younger (16-24) non-smokers supported the results in Shang et al. (2018) as there was statistically significant increased selection of various flavored e-cigarette products compared to tobacco, including coffee ($p<0.01$), cherry ($p<0.0001$) and menthol ($p<0.001$). Czoli et al. (2016) importantly compared an older smoker (25+) group to younger smokers showing a statistically significant increase in selection of tobacco flavored products ($p<0.0001$) by older smokers. These studies support a significant impact of flavor in youth non-smoker's selection of tobacco products but raise questions on whether smokers or older adults have distinct preferences for tobacco flavored or cherry flavored products.

4.5.2 Young adult and older adult preferences for ENDS

Two DCE studies (Buckell et al. 2018; Pesko et al. 2016) did not include youth but show significant increased selection of flavored products by young adults (18-24 or 18-25 years of age) compared to older adults. Buckell et al. (2018) assessed smokers and recent quitters and reported that older adults (26-64 years of age) have statistically significant selection of tobacco flavored *cigarettes*, while younger adults prefer menthol *cigarettes* and all *e-cigarettes* (flavored and tobacco). It should be noted that tobacco was the least preferred (0.26 (SE: 0.099)) among these youth-preferred products. This supports the finding in Czoli et al. (2016) for an older adult preference for tobacco flavor but indicates that young adults have a strong preference against tobacco cigarettes preferring any other option. Pesko et al. (2016) assessed ENDS selection among adult smokers finding that younger adults (18-24) were 3.7 percentage points (95% CI: 2.0-5.5) more likely to choose ENDS when multiple flavors are available compared to older adults ($p<0.001$). This study by Pesko et al. (2016), however may not have offered a distinct difference between flavors as it offered only a choice between regular/menthol ENDS and "many flavors." Nevertheless, it provides continued modest support of older adults' statistically significant selection of products without flavors (excluding menthol).

Overall two studies (Buckell et al. 2018; Czoli et al. 2016) offered support for older adult smokers' increased selection of tobacco flavored products over flavored ENDS products. Pesko et al. (2016) offered modest support for older adult smokers' preference against flavored (excluding menthol) ENDS products.

4.5.3 Other flavored products: Waterpipes

Salloum et al. (2015) assessed the role of flavor in college waterpipe smoker's selection of waterpipe products. In this subset of young adults, there was an overall preference for flavored products and an adverse role of tobacco flavor that was associated with 78% lower odds of selection. This also provides supportive evidence of Czoli et al.'s (2016) findings of young adults' selection of flavored products over tobacco flavored products.

4.5.4 Limitations

DCE studies are generally limited as they are based on hypothetical choices that could deviate from actual behavior. These types of studies cannot replicate choice in the real world, which would have been among various tobacco products and brands. However, these types of studies may limit the role brand-specific marketing plays in selection of products and better represent the impact of a single attribute unbiased by marketing. Furthermore, four studies (Buckell et al. 2018; Pesko et al. 2016; Salloum et al. 2015; Shang et al. 2018) contained current smokers, ENDS users, and/or recent quitters who each have the real-world experience to make well-informed choices and the results may more closely match their actual behavior in the same scenario. Relatedly, rapid product evolution could make the selected product profiles inapplicable, although each study selected features based on market availability. Two studies (Pesko et al. 2016; Shang et al. 2018) went further and gave users the option of using their regularly used product.

One study (Buckell et al. 2018) added product types as a varying attribute, while other studies compared choices within a specific product type. This may force a choice that may never be made in the real world, limiting the study's use for predicting policy effects. The specific tobacco product likely plays a role in selection as just the device type of ENDS plays a role in selection.

Additionally, this subset of studies would greater benefit policy formation if it consistently assessed youth as distinct from adults and compared the impact of flavors on product selection between youth and adult smokers. Only one study exclusively focused on youth, one study mixed effects for underage smokers and young adults, and the remaining studies focused on adults with two comparing young adults to older adult selections. Each contribute evidence supporting heterogenous flavor preferences by age and smoker status, but the lack of consistency prevents firmer conclusions.

Besides product characteristics, the slightly different time periods of the studies may lead to different conclusions in studies, as social norms around different products could be impacting selection.

Lastly, studies differed in quality of reporting of effects, as two studies (Buckell et al. 2018; Pesko et al. 2016) did not discuss relative importance for each attribute towards decision-making.

4.6 Conclusion

This review of discrete choice experiment studies found two trends in the evidence: an increased selection of flavored tobacco products compared to non-flavored products by youth, and an increased selection by older adults of tobacco flavored products compared to younger adults. These studies generally pointed to important heterogeneity in selected products by age. However, results among young adults were more varied and difficult to interpret.

5. FIRST-TIME ADULT AND YOUTH USER'S SELECTION OF FLAVORED PRODUCTS IN PATH

5.1 Purpose

The Population Assessment of Tobacco and Health (PATH) study is a longitudinal panel survey that plans to follow the same cohort of people. This section of the report aims to use data from the recently released third wave of PATH. This section assessed what proportion of youth or adults tried flavored products the first time they tried a tobacco product. Waves of the survey vary slightly in data for each tobacco product, but each wave includes information on snus and smokeless tobacco.

5.2 Methods

The *survey* package (version 3.33.2) in the R statistical computing environment (version 3.5.0) were used to carry out the analysis. The survey design was accounted for using the provided Fay replication weights prior to calculation of survey statistics or logistic regression.

Between PATH waves one and two, the PATH survey began collecting data on whether participants did not recall whether their first product was flavored. Consequently, the results for wave one should be interpreted as users among those who recall whether their first product was flavored or non-flavored. The remaining studies included participants who did not recall whether their first product was flavored or non-flavored. Proportions for waves 2 and 3 are likely a better representation of whether flavor played a role in the selection process, as participants that did not recall may not have considered flavor as important.

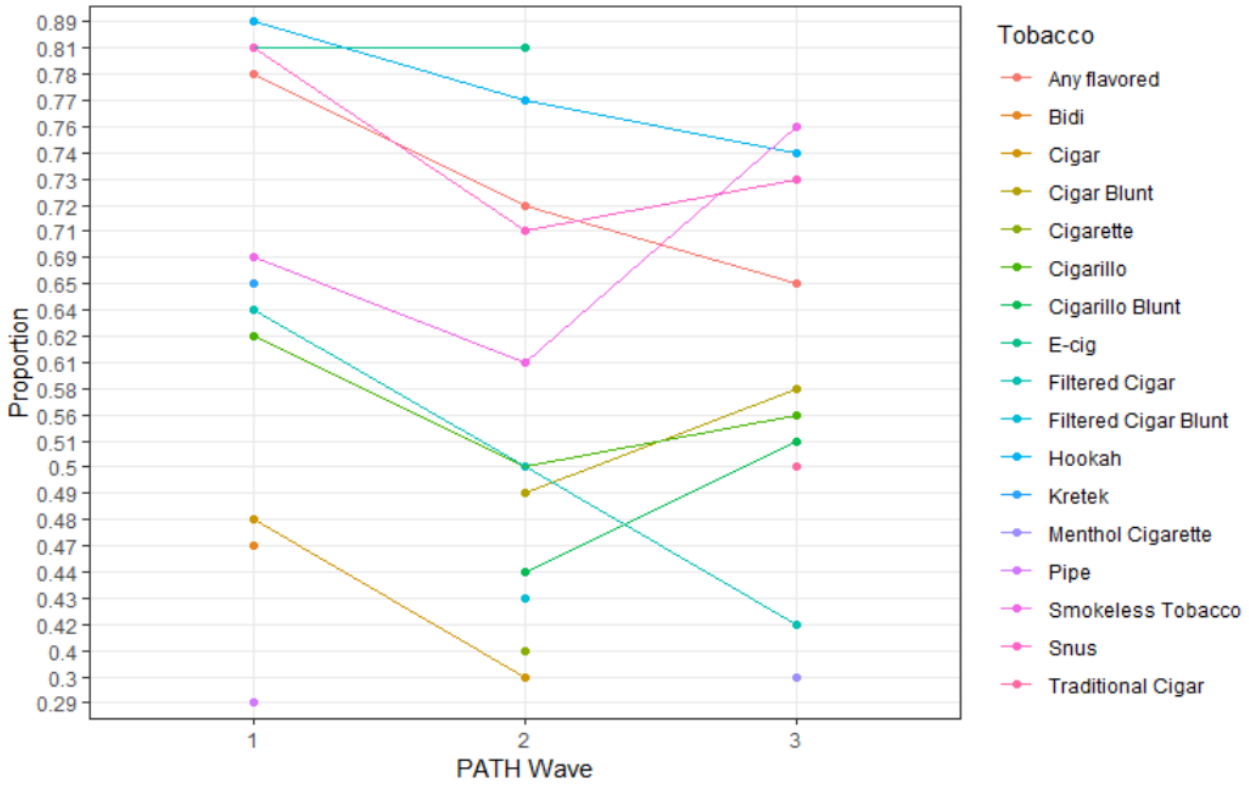
Proportions for each tobacco type are included in the results despite our focus on smokeless tobacco and snus in the discussion.

5.3 Results

5.3.1 Proportions of youth per wave whose first use of a product was flavored

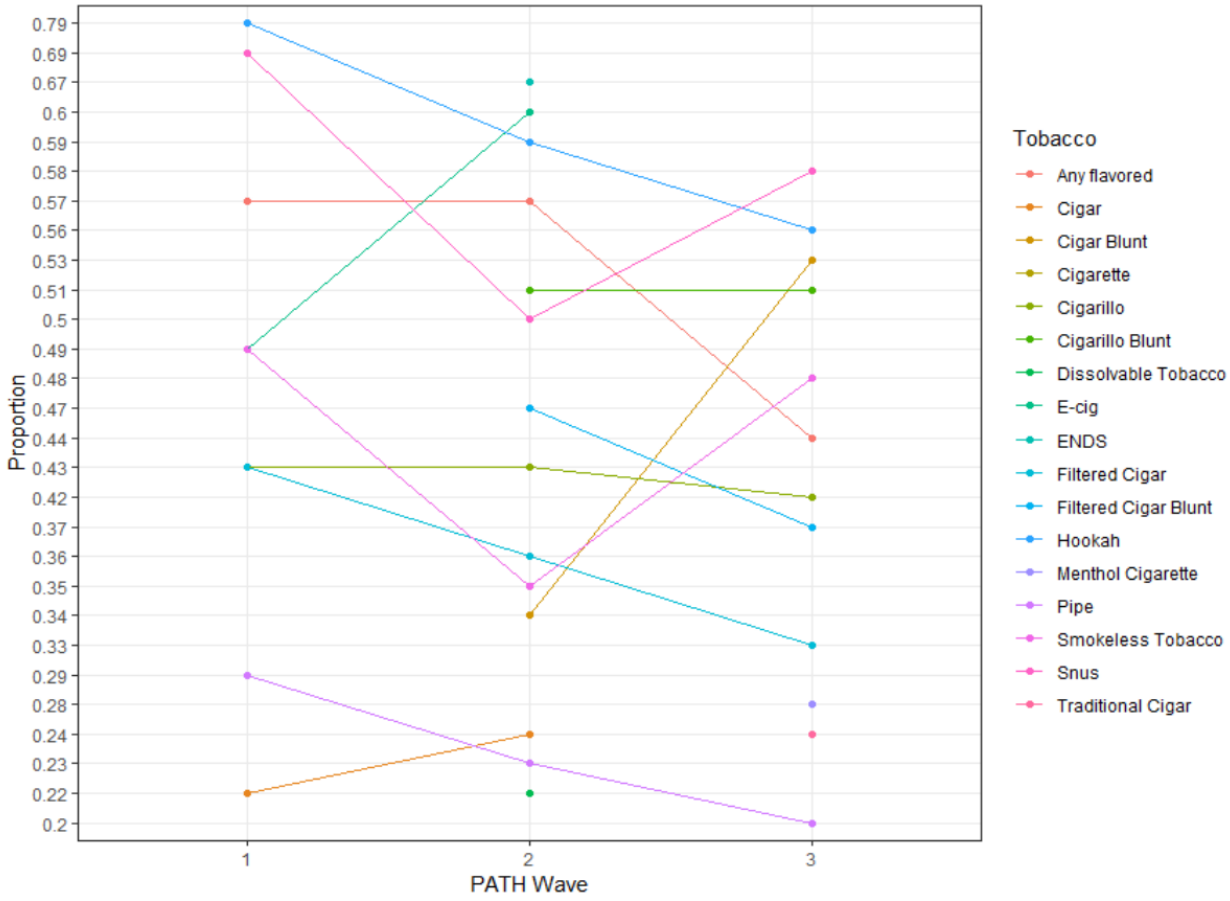
Tobacco	Wave 1 (9/2013-12/2014)	Wave 2 (10/2014-10/2015)	Wave 3 (10/2015-10/2016)
Any flavored	0.78 (0.76-0.8)	0.72 (0.69-0.74)	0.65 (0.61-0.69)
Bidi	0.47 (0.26-0.68)	NA	NA
Cigar	0.48 (0.42-0.54)	0.3 (0.2-0.41)	NA
Cigar Blunt	NA	0.49 (0.33-0.64)	0.58 (0.37-0.78)
Cigarette	NA	0.4 (0.35-0.45)	NA
Cigarillo	0.62 (0.59-0.65)	0.5 (0.43-0.57)	0.56 (0.45-0.67)
Cigarillo Blunt	NA	0.44 (0.37-0.51)	0.51 (0.44-0.58)

E-cig	0.81 (0.79-0.84)	0.81 (0.78-0.84)	NA
Filtered Cigar	0.64 (0.58-0.7)	0.5 (0.37-0.62)	0.42 (0.04-0.8)
Filtered Cigar Blunt	NA	0.43 (0.12-0.74)	NA
Hookah	0.89 (0.87-0.91)	0.77 (0.72-0.82)	0.74 (0.67-0.81)
Kretek	0.65 (0.52-0.77)	NA	NA
Menthol Cigarette	NA	NA	0.3 (0.25-0.35)
Pipe	0.29 (0.23-0.36)	NA	NA
Smokeless Tobacco	0.69 (0.65-0.73)	0.61 (0.54-0.68)	0.76 (0.67-0.84)
Snus	0.81 (0.76-0.86)	0.71 (0.61-0.81)	0.73 (0.63-0.84)
Traditional Cigar	NA	NA	0.5 (0.35-0.65)



5.3.2 Proportions of adult per wave whose first use of a product was flavored

Tobacco	Wave 1	Wave 2	Wave 3
Any flavored	0.57 (0.56-0.58)	0.57 (0.55-0.58)	0.44 (0.41-0.47)
Cigar	0.22 (0.21-0.23)	0.24 (0.21-0.27)	NA
Cigar Blunt	NA	0.34 (0.17-0.51)	0.53 (0.42-0.64)
Cigarette	NA	0.36 (0.3-0.43)	NA
Cigarillo	0.43 (0.42-0.45)	0.43 (0.37-0.48)	0.42 (0.36-0.48)
Cigarillo Blunt	NA	0.51 (0.43-0.59)	0.51 (0.47-0.56)
Dissolvable Tobacco	NA	0.22 (0.12-0.33)	NA
E-cig	0.49 (0.48-0.5)	0.6 (0.57-0.63)	NA
ENDS	NA	0.67 (0.65-0.69)	NA
Filtered Cigar	0.43 (0.41-0.45)	0.36 (0.33-0.4)	0.33 (0.27-0.39)
Filtered Cigar Blunt	NA	0.47 (0.06-0.87)	0.37 (0.17-0.57)
Hookah	0.79 (0.78-0.8)	0.59 (0.56-0.63)	0.56 (0.5-0.62)
Menthol Cigarette	NA	NA	0.28 (0.2-0.36)
Pipe	0.29 (0.27-0.3)	0.23 (0.18-0.29)	0.2 (0.11-0.28)
Smokeless Tobacco	0.49 (0.47-0.51)	0.35 (0.28-0.43)	0.48 (0.37-0.59)
Snus	0.69 (0.67-0.72)	0.5 (0.43-0.56)	0.58 (0.51-0.66)
Traditional Cigar	NA	NA	0.24 (0.19-0.29)



5.3.3 Youth and Adult Proportion for Snus and Smokeless tobacco only

	Wave 1		Wave 2		Wave 3	
Tobacco	Youth	Adult	Youth	Adult	Youth	Adult
Any flavored	0.78 (0.76-0.8)	0.57 (0.56-0.58)	0.72 (0.69-0.74)	0.57 (0.55-0.58)	0.65 (0.61-0.69)	0.44 (0.41-0.47)
Smokeless Tobacco	0.69 (0.65-0.73)	0.49 (0.47-0.51)	0.61 (0.54-0.68)	0.35 (0.28-0.43)	0.76 (0.67-0.84)	0.48 (0.37-0.59)
Snus	0.81 (0.76-0.86)	0.69 (0.67-0.72)	0.71 (0.61-0.81)	0.50 (0.43-0.56)	0.73 (0.63-0.84)	0.58 (0.51-0.66)

5.4 Discussion

At each wave, a large proportion of youth identified consuming a flavored product their first time using any tobacco product. The results for smokeless tobacco users and snus users are particularly relevant for this report. Flavored smokeless tobacco users in waves 1-3 were respectively 0.69 (95% CI 0.65-0.73), 0.61 (95% CI: 0.54-0.68), 0.76 (0.67-0.84). At least 60% of first-time users of smokeless tobacco selected flavored products in each wave. The results for flavored snus users in waves 1-3 were respectively 0.81 (95% CI: 0.76-0.86), 0.71 (95% CI: 0.61-0.81), and 0.73 (95% CI: 0.63-0.84). At least 70% of first-time users of snus pouches selected flavored products in each wave. The

results suggest the majority of first-time youth users of snus and smokeless tobacco consumed flavored varieties.

At each wave, a majority of adult users identified consuming a flavored tobacco product their first time using any tobacco products. However, flavored smokeless tobacco users in waves 1-3 were respectively 0.49 (95% CI: 0.47-0.51), 0.35 (95% CI: 0.28-0.43), 0.48 (95% CI: 0.37-0.59). No waves report first-time users of smokeless tobacco selecting flavored products over half the time. The results for flavored snus users in waves 1-3 were respectively 0.69 (95% CI: 0.67-0.72), 0.5 (95% CI: 0.43-0.56), 0.58 (95% CI: 0.51-0.66). At least 50% of first-time users of snus pouches selected flavored products in each wave.

Comparatively, first-time adult users selected flavored snus or smokeless tobacco products in each wave less than first-time youth users.

6. OVERALL CONCLUSION BASED ON EVIDENCE FROM REVIEWS, FLAVOR BAN STUDIES, DISCRETE CHOICE EXPERIMENTS, AND PATH DATA

All evidence displays typical limitations of their respective study design, however there is demonstrated consistency across study designs of an association between the availability of flavored products and adolescent or younger adult interest in, and usage of tobacco and nicotine products.

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Appendix A: Search Results Tracking Table

Databases and Proposed Search Queries for Flavor-related primary studies		
Database	**Search Query**	**Notes**
PubMed	(("chew" AND "tobacco") OR ("alternative" AND ("nicotine" OR "tobacco")) OR "potential reduced exposure products" OR ("spit" AND "tobacco") OR "non-cigarette tobacco" OR ("chewing" AND "tobacco") OR "dissolvable tobacco" OR (dissolvable AND tobacco) OR "dry snuff" OR "non-combustible PREPs" OR ("smokeless tobacco") OR snuff OR snus OR ("personal" and "vaporizers") OR "non-cigarette tobacco" OR e-cig OR e-cigarette OR "electronic cigarette" OR "electronic nicotine delivery" OR vape OR vaping OR hookah OR shisha OR "modified risk tobacco product") AND (flavor OR flavors OR flavoring OR flavoured OR flavored OR attractiveness OR attract OR preferences OR preference OR prefer OR appeal OR reason OR reasons OR susceptibility OR receptivity)	1,358 results (10/10/18)
Scopus	TITLE-ABS-KEY ((("chew" AND "tobacco") OR ("alternative" AND ("nicotine" OR "tobacco")) OR "potential reduced exposure products" OR ("spit" AND "tobacco") OR "non-cigarette tobacco" OR ("chewing" AND "tobacco") OR "dissolvable tobacco" OR (dissolvable AND tobacco) OR "dry snuff" OR "non-combustible PREPs" OR ("smokeless tobacco") OR snuff OR snus OR ("personal" and "vaporizers") OR "non-cigarette tobacco" OR e-cig OR e-cigarette OR "electronic cigarette" OR "electronic nicotine delivery" OR vape OR vaping OR hookah OR shisha OR "modified risk tobacco product") AND (flavor OR flavors OR flavoring OR flavoured OR flavored OR attractiveness OR attract OR preferences OR preference OR prefer OR appeal OR reason OR reasons OR susceptibility OR receptivity)) Limit to articles and articles in press, and English only	1,317 results (10/10/18)

Appendix B: Reproduced Study Results from Reviews

Feirman et al. (2016) Supplementary Tables

Supplementary Data – Table of Contents

Supplementary Table 1. Electronic database search terms

Database	Flavor key terms	Tobacco key terms
PubMed	Flavoring Agents* [Mesh] OR “flavor”[tw] OR “flavour”[tw] OR “flavors” [tw] OR “flavours”[tw] OR “flavored”[tw] OR “flavoured”[tw] OR “flavoring”[tw] OR “flavouring”[tw] OR “candy” [Mesh] OR “candy”[tw] OR “herb”[tw] OR “spice”[tw] OR “sweet”[tw] OR “taste” [Mesh] OR “taste” [tw] OR “clove” [tw] OR “sweetening agents” [Mesh] OR (“additive"[tw] AND “tobacco”[tw]) OR (“additives”[tw] AND “tobacco”[tw])	“Smoking” [Mesh] OR Tobacco* [Mesh] OR Tobacco, Smokeless* [Mesh] OR “Tobacco Products” [Mesh] OR “Tobacco Use Cessation” [Mesh] OR “tobacco” [tw] OR cigar* [tw] OR “bidi”[tw] OR “bidis”[tw] OR “smokeless”[tw] OR “snus”[tw] OR “smoker”[tw] OR “smokers”[tw] OR “e-cigarette”[tw] OR “e-cigarettes” OR “nicotine” [tw] OR Nicotine*[Mesh] OR “hookah” [tw] OR “waterpipe” [tw] OR “waterpipes” [tw] OR “shisa” [tw] OR “narghile” [tw]
CINAHL	MW Flavoring Agents OR Flavor OR Taste OR TX flavor* OR flavour* OR candy OR herb OR spice OR spices OR sweet OR taste OR clove OR “sweetening agents” OR (TX “additive" AND “tobacco”) OR (TX “additives” AND “tobacco”)	MJ Smoking OR Tobacco OR Smokeless OR TX Smoking OR Tobacco OR Smokeless OR cigar* OR bidi OR bidis OR snus OR smoker OR smokers OR e-cigarette* OR nicotine OR hookah* OR waterpipe* OR water-pipe* OR shisha OR narghile
LILACS	MH:"Flavoring Agents" OR MH:"sweetening agents" OR MH:"candy" OR MH:"spices" OR MH:"taste" OR flavor$ OR flavour$ OR flavored OR flavoured OR flavoring OR flavouring OR herb OR taste OR clove OR sweet OR doce OR dulce OR additive$ OR aditivo	MH:"tobacco" OR MH:"Smoking" OR MH:"Cigarette" OR MH:"tobacco, smokeless" OR MH:"tobacco use cessation" OR MH:"tobacco products" OR MH:"Smoking Cessation" OR MH: "tobacco use disorder" OR MH: "Consumption of tobacco-derived products" OR tobacco OR bidi$ OR smokeless OR snus OR e-cigarette$ OR cigarette$ OR cigarillo$ OR cigar$ OR charuto OR smoker$ OR fumador OR fumante OR nicotine OR nicotina OR hookah OR narguille OR narghile OR waterpipe$ OR water-pipe$ OR cachimbo$ OR pipa OR shisha
PychInfo	SU Taste Perception OR “Flavoring Agents” OR “flavor” OR “flavour” OR “flavors” OR “flavours” OR “flavored” OR “flavoured” OR “flavoring” OR “flavouring” OR “candy” OR “herb” OR “spice” OR “sweet” OR “taste” OR “clove” OR “sweetening agents” OR (“additive" AND “tobacco”) OR (“additives” AND “tobacco”	SU Tobacco Smoking OR SU Smokeless Tobacco OR SU Smoking Cessation OR SU Nicotine OR “Smoking” OR “Tobacco” OR “Smokeless Tobacco” OR “Tobacco Products” OR “Tobacco Use Cessation” OR “tobacco” OR “cigar” OR “cigars” OR “cigarette” OR “cigarettes” OR “cigarillo” OR “cigarillos” OR “bidi” OR “bidis” OR “smokeless” OR “snus” OR “smoker” OR “smokers” OR “e-cigarette” OR “e-cigarettes” OR “nicotine” OR “hookah” OR “waterpipe” OR “waterpipes” OR “shisa” OR “narghile”
Embase	‘flavoring agent’ OR ‘flavor’:ab,ti OR ‘flavour’:ab,ti OR ‘flavors’:ab,ti OR ‘flavours’:ab,ti OR ‘flavored’:ab,ti OR ‘flavoured’:ab,ti OR ‘flavoring’:ab,ti OR ‘flavouring’:ab,ti OR ‘candy’:ab,ti OR ‘sugar’ OR ‘herb’ OR ‘herb’:ab,ti OR ‘spice’ OR ‘spice’:ab,ti ‘sweet’:ab,ti OR ‘sweetness’ OR ‘taste’ OR ‘taste’:ab,ti OR ‘clove’ OR ‘clove’:ab,ti OR ‘sweetening agent’/mj OR (‘additive’:ab,ti AND ‘tobacco’:ab,ti) OR (‘additives’:ab,ti AND ‘tobacco’:ab,ti)	‘Smoking’ OR ‘tobacco’/exp OR ‘tobacco’:ab,ti OR ‘smokeless tobacco’ OR ‘smoking cessation’ OR ‘cigar’:ab,ti OR ‘cigars’:ab,ti OR ‘cigarette’:ab,ti OR ‘cigarettes’:ab,ti OR ‘cigarillo’:ab,ti OR ‘cigarillos’:ab,ti OR ‘bidi’:ab,ti OR ‘bidis’:ab,ti OR ‘smokeless’:ab,ti OR ‘snus’:ab,ti OR ‘e-cigarette’:ab,ti OR ‘e-cigarettes’:ab,ti OR ‘nicotine’ OR ‘nicotine gum’ OR ‘hookah’:ab,ti OR ‘waterpipe’:ab,ti OR ‘waterpipes’:ab,ti OR ‘shisa’:ab,ti OR ‘narghile’:ab,ti

Supplementary Table 2. Sample description and use of non-flavored tobacco products

Study ID*	Study Aim and Brief Sample Description	Flavored Products	Non-flavored tobacco use % (95% CI)	
Cohort – cross sectional (one time point)				
Aljarrah, 2009	Assess characteristics and harm beliefs of hookah in 235 hookah café patrons in and nearby downtown San Diego aged 17-35 (mean 21.8); 57% male	Hookah	**Cigarettes**	
			Yes	28.4%
			No	71.6%
			Hookah	
			Daily	13.5%
			Weekly	35.2%
			Monthly	24.4%
			Six month	27.0%
CDC, 2003	Summarize tobacco use prevalence among 26119 middle and high school students nation-wide (2002 National Youth Tobacco Survey) and estimate changes in prevalence since 2000	Bidis,** Kreteks	**Tobacco**	
			Middle school students	
			2002 - Any current use	13.3% (±1.4)
			2000 - Any current use	15.1%(±1.5)
			High school students	
			2002 - Any current use	28.4%(±1.7)
			2000 – Any current use	34.5%(±1.9)
			Cigarettes	
			Middle school students	
			2002 – Current use	10.1%(±1.2)
			2000 – Current use	11.0%(±1.2)
			High school students	
			2002 – Current use	22.9%(±1.6)
			2000 – Current use	28.0%(±1.7)
			Cigars	
			Middle school students	
			2002 – Current use	6.0%(±0.7)
			2000 – Current use	7.1%(±1.0)
			High school students	
			2002 – Current use	11.6%(±0.9)
			2000 – Current use	14.8%(±1.1)
			Pipes	
			Middle school students	
			2002 – Current use	3.5%(±0.5)
			2000 – Current use	3.0%(±0.4)
			High school students	
			2002 – Current use	3.2%(±0.6)
			2000 – Current use	3.3%(±0.4)
			Smokeless Tobacco	
			Middle school students	
			2002 – Current use	3.7%±0.8
			2000 – Current use	3.6%(±0.9)
			High school students	
			2002 – Current use	6.1%(±1.1)
			2000 – Current use	6.6%(±0.9)
Dawkins, 2013***	Investigate the nature of e-cigarette users, its use, and effects among 1347 respondents (mean age 43.49, SD 11.99) to an online survey hosted on the University of East London website; 70% male	E-cigarettes	**Cigarettes**	
			Former	83%
			Current	16%
			Never	4%
			E-cigarettes	
			Ever	100%
King, 2013	Determine national and state-specific prevalence and correlates of flavored cigar use among 118215 adults aged ≥18 years (2009–2010 National Adult Tobacco Survey)	Cigars	**Cigars/cigarillos/small cigars**	
			Current	4%
			Ever	6.6% (6.3-7.0)
Klein, 2008	Assess flavored cigarette use by age in two national surveys. National Youth Smoking Cessation Survey (2004-05): 1444 17-24 years-olds, 53.6% male; Assessing Hardcore Smoking Survey (2004-05): 825 adults aged ≥25, 53.7% male	Cigarettes	**Cigarettes**	
			Current	100%
Pepper, 2013	Explore awareness of and willingness to try e-cigarettes among 228 11-17 year-old males (mean 15.1, SD 2.1) whose parents were members of a panel of U.S. households; 100% male	E-cigarettes	**Cigarettes**	
			Nonsmoker	91%
			Smoker	9%
			E-cigarettes	

			Ever tried (were excluded from analysis)	0.88%
			Never tried	99.12%
Regan, 2012	Assess popularity of smokeless and flavored products in 4556 adults aged ≥18 (2009 ConsumerStyles)	Cigars	**Dissolvable tobacco**	
			Ever	0.5%
			Current	0.3%
			Snus	
			Ever	5.4%
			Current	1.8%
Smith-Simone, 2008	Investigate knowledge, attitudes, beliefs, and smoking patterns of waterpipe users in U.S. young adults. Café sample: 101 tobacco waterpipe users aged ≥18, 71.3% male; Internet sample: 201 respondents aged ≥18, 80.1% male	Hookah	**Tobacco other than hookah/cigarettes**	
			Past month use	33%
			None	67%
			Hookah and cigarettes	
			Past month	25.9%
			Hookah and other tobacco products	
			Past month	20.0%
			Cigarettes	
			Past month	53.7%
			No past month	46.3%
			Hookah	
			Ever use	100%
			Past month use	94.1%
			No past month use	5.9%
			Frequency of use	
			Yearly	11.5%
			Monthly	28.5%
			Weekly	41.2%
			Daily	18.8%
			Past month frequency	
			0-1 times	18.4%
			2-10 times	50.7%
			11-20 times	18.4%
			21+ times	12.5%
			Hookah and no other substance	
			Past month	37.8%
Soldz, 2003	Assess prevalence of cigar, bidi, and kretek use and characteristics of users among 5016 students in grades 7-12 in Massachusetts; 48.9% male	Kreteks	**Cigarettes**	
			Ever	33.7% (31.5-36.0)
			Current	14.4% (13.0-15.9)
			All cigars	
			Ever	18.2% (16.7-19.9)
			Current	5.9% (5.1-6.7)
			Regular cigars	
			Ever	16.4% (14.9-18.0)
			Current	4.7% (4.1-5.4)
			Little cigars/cigarillos	
			Ever	11.9% (10.7-13.2)
			Current	3.4% (2.8-4.0)
			Smokeless tobacco	
			Ever	4.6% (4.0-5.4)
			Current	1.7% (1.3-2.2)
			Bidis	
			Ever	6.5% (5.6-7.5)
			Current	2.3% (1.8-3.1)
Soldz, 2005	Investigate attitudes toward and beliefs about kreteks among 5016 students in grades 7-12 in Massachusetts; 48.9% male	Kreteks	**Cigars**	
			No use	81.8%
			Ever	12.3%
			Current	5.9%
			Bidis (among those who had heard of bidis)	
			No use	72.0%
			Ever	20.2%
			Current	7.1%
Suftin, 2014	Investigate hookah use (tobacco and other substances) in 1509 university students in North Carolina; 46% male	Hookah	**Cigarettes**	
			Never smoker	30%
			Former/experimenter	29.0%
			Current nondaily	33%

			Current daily **Hookah** Ever	8.0% 44%
Vander Weg, 2005	Examine the prevalence and correlates of smokeless tobacco use among 9087 female recruits (mean age 20.2, SD 2.6) who entered Air Force Basic Military Training from Oct. 1999 to Oct. 2000; 0% male	Kreteks	**Cigarettes** Daily or occasional **Smokeless tobacco** Daily or occasional Former Ever	 30.4% 0.4% 0.2% 6.6%
Vander Weg, 2008	Evaluate alternative tobacco product use among 31107 active duty recruits who entered Air Force Basic Military Training from Oct. 1999 to Sept. 2000; 74.8% male	Kreteks	**Cigarettes** Current **Cigars** 12.3% (11.8-12.8) **Pipes** 1.1% (0.9-1.2) **Smokeless** 6.7% (6.3-7.0) **Bidis** 2.0% (1.8-2.3)	 32.7%
Villanti, 2013	Examine use and predictors of flavored tobacco in a nationally representative sample of 982 young adults aged 18–34 years	Chew, Cigars, Cigarettes, E-cigarettes, Hookah, Pipes, Snus, Spit, Orbs, Other non-combustible products	**Any tobacco product** Past 30 day	 100%
Quasi-experimental and experimental studies				
Ashare, 2007	Assess 424 college students' expectancies for and intentions to try flavored and non-flavored cigarettes; mean age: nonsmokers 19.2(SD 2.2), susceptible/experimenter 19.3(SD 3.4), regular 19.3(SD 2.1); 43% male	Cigarettes	**Cigarettes** Nonsmoker Susceptible/Experimenter Regular	 59% 26% 15%
Cobb, 2011	Compare subjective effects of waterpipe tobacco and cigarette use in 54 adults aged 18-50 (mean 21.2, SD 2.3) from the Richmond, VA community; 67% male	Hookah	**Cigarettes** At least 5/wk for past mo. **Hookah** At least 2/mo. for past 6 mo.	 100% 100%
Blank, 2011a	Determine the extent to which acute effects of waterpipe tobacco smoking were due to nicotine exposure in 37 non-regular marijuana users aged 18-50 (mean 20.5, SD 12.77) with no past use of other drugs; 78.4% male	Hookah	**Cigarettes** Current >5/month **Hookah** Current 2-5 times/month	 100% 100%
Blank, 2011b	Evaluate the cardiovascular response, toxicant exposure, subjective effects, and puffing topography of cigarillos in 16 volunteers aged 18-55 (mean 27.7, SD10.8) from the greater Richmond, VA community; 62.5% male	Cigars	**Cigarettes** Smoker Nonsmoker **Cigarillos (Black & Milds)** Used 5+ Black & Mild cigarillos/mo. for 6mo+ **Cigarettes and Cigarillos (Black & Milds)** Concurrent use	 56% 44% 100% 56%
Malson, 2002	Evaluate the cardiovascular response, toxicant exposure, subjective effects, and puffing topography of cigarillos in 16 volunteers aged 18-55 (mean 27.7, SD10.8); 90% male	Bidis	**Cigarettes** Current (regular)	 100%
Malson, 2003	Compare the changes in exhaled CO, cardiovascular effects, and subjective effects of clove versus conventional cigarettes in 10 volunteers aged 19-46 (mean 30.3); 70% male	Kreteks	**Cigarettes** Current (regular) **Bidis** Ever use	 100% 100%
Manning, 2009	Examine the interactive effects of package flavor descriptors and sensation seeking on brand perceptions in a sample of 253 high school students (mean age 15.7) at a school in the United States; 40% male	Cigarettes	**Cigarettes** *Southeastern School* Past month *Central School* Past month	 26% 17%
O'Connor, 2007	Compare puff topography and ratings for flavored and unflavored cigarette in 20 participants aged 18-30; 50% male	Cigarettes	**Cigarettes** Current nonmenthol	 100%
Qualitative				

Choi, 2012	Explore perceptions of and intention to try snus, dissolvable tobacco products, and electronic cigarettes among 66 residents of the Minneapolis-St. Paul area aged 18-26; 39% male	E-cigarettes, Snus, Orbs, Other non-combustible products	**Cigarettes** Past 30 day No past 30 day **Other combustible products** Past 30 day No past 30 day **Smokeless tobacco** Past 30 day No past 30 day	 70% 30% 15% 85% 3% 97%
Griffiths, 2011	Investigate hookah consumption in 20 current or past hookah smokers aged 18-23 (mean 20.1); 50% male	Hookah	**Cigarettes** Smoker Socially Occasionally Past Nonsmoker **Hookah** Current or past	 5% 10% 10% 10% 65% 100%
Lavo, 2004	Examine perspectives of smokeless tobacco among 20 adjudicated adolescents aged 15-17 (mean 15.85) in Northeast Pennsylvania	Chew, Spit, Other non-combustible products	**Smoke tobacco** 15% **Smokeless tobacco** 20% **Smoke and smokeless tobacco** 60%	
Liu, 2012	Examine perceptions of smokeless tobacco products and packaging among smokeless tobacco users in Ohio; 23 adolescents (mean age 17.2, SD 0.8) and 38 adults (mean age 28.9, SD 12.9); 100% male	Chew, Snus, Orbs, Other non-combustible products	**Cigarettes** *Adolescents* Smokers Nonsmokers *Adults* Smokers Nonsmokers **Smokeless Tobacco** *Adolescents* </= 5 days per week 6-7 days/week Missing *Adults* <=5 days/week 6-7 days/week *Total sample* Current	 56.5% 39.1% 31.6% 39.1% 43.5% 43.5% 13% 34.2% 65.8% 100%
Richter, 2008	Investigate the appeal and use of nontraditional tobacco products among 137 smokers aged 18-22 in Dallas, Texas and Chattanooga, Tennessee	Hookah,** Kreteks	**Cigarettes** Current **Cigars** Ever (Swisher Sweets) Ever (Black & Mild) **Bidis** Ever	 100% 87% 96% 23%
Sifaneck, 2005	Explore reasons for tobacco products choices among 92 marijuana/blunt users aged 14-35 in New York; 57% male	Cigars	**Cigar-for-blunts** 100%	
Other				
Oliver, 2013	In 468 current smokeless tobacco users (aged 18-70), examine brand flavor choices over the course of use; mean age: no current flavor use 37.3(7.7); current flavor use 32.5(7.8)	Smokeless tobacco products	**Smokeless tobacco** Current (non-flavored)	 41.2%
Case report/case series				
Al-Saieg, 2007	Describe acute eosinophilic pneumonia following flavored cigar smoking in two patients aged 23 and 53 who presented at a hospital in Youngtown, OH; 100% male	Cigars	-	
CDC, 1985	Describe severe illnesses possibly resulting from smoking clove cigarettes in two patients aged 19 and 16 who presented at a hospital in California; 100% male	Kreteks	-	
Guidotti, 1989	Describe an 18 year-old who developed pneumonia complicated by lung abscess after smoking a clove cigarette; 0% male	Kreteks	-	

*First author, year published

**Product was described by authors as being flavored, but question was not given confirming that participants were asked about the flavored version of these products

***Data was collected with participants recruited within the United States, as well as internationally. Results are not segmented by country.

Supplementary Table 3. Flavored tobacco use, assessed by age

Study ID*	Sample	Measures/Analysis	Age (years) or Population	% (95% CI)	Main Finding
King, 2013	2009-2010 National Adults Tobacco Survey	Past 30 day flavored cigar smoking among ever cigar smokers	18-24 25-44 45-64 ≥65 All	9.1 (7.8–10.5) 3.1 (2.7–3.6) 1.4 (1.2–1.7) 0.2 (0.1–0.3) 2.8 (2.6-3.1)	No statistical test performed
		Past 30 day flavored cigar smoking among current cigar smokers	18-24 25-44 45-64 ≥65 All	57.1 (51.4–62.5) 43.2 (38.7–47.8) 28.9 (25.1–33.2) 13.4 (9.3–18.9) 42.9 (40.1-45.7)	No statistical test performed
Klein, 2008	National Youth Smoking Cessation Survey	Chi-squared test for independence, past 30 day use of any flavored cigarette (Camel Exotic Blends, Kool Smooth Fusion, Salem Silver Label), by age	17 18-19 20-21 22-23 24-26 All	22.8 (14.8–33.4) 21.7 (17.1–27.3) 10.1 (7.4–13.6) 8.8 (6.1–12.6) 9.0 (6.2–13.1) 11.9 (10.2-13.8)	Age significantly associated with any flavored tobacco use (**p<.001**)
		Chi-squared test for independence, past 30 day use of Camel Exotic Blends, by age	17 18-19 20-21 22-23 24-26 All	15.8 (9.2–25.8) 19.4 (15.0–24.7) 9.8 (7.2–13.3) 8.3 (5.6–12.1) 7.5 (4.9–11.3) 10.5 (8.9-12.3)	Age significantly associated with any flavored tobacco use (**p<.01**)
		Chi-squared test for independence, past 30 day use of Kool Smooth Fusion Cigarettes, by age	17 18-19 20-21 22-23 24-26 All	3.6 (1.3–9.5) 2.7 (1.2–5.9) 0.7 (0.2–2.3) 0.5 (0.1–2.0) 0.7 (0.2–2.9) 1.1 (0.7-1.8)	Chi-squared test for independence produced non-significant results
		Chi-squared test for independence, past 30 day use of Salem Silver Label Cigarettes, by age	17 18-19 20-21 22-23 24-26 All	6.5 (2.8–14.3) 2.2 (1.0–4.7) 1.3 (0.6–2.9) 1.4 (0.6–3.4) 1.5 (0.6–3.8) 1.8 (1.2-2.7)	Chi-squared test for independence produced non-significant results
Klein, 2008	Assessing Hardcore Smoking Survey	Chi-squared test for independence, past 30 day use of any flavored cigarette (Camel Exotic Blends, Kool Smooth Fusion, Salem Silver Label) by age	25-39 40-54 >55	11.2 (5.9–20.4) 6.2 (3.3–11.1) 0.8 (0.2–2.4)	Age significantly associated with any flavored tobacco use (**p<.01**)
		Chi-squared test for independence, past 30 day use of Camel Exotic Blends, by age	25-39 40-54 >55	9.1 (4.1–19.0) 5.0 (2.4–10.0) 0.8 (0.2–2.4)	Age significantly associated with any flavored tobacco use (**p<.05**)
		Chi-squared test for independence, past 30 day use of Kool Smooth Fusion Cigarettes, by age	25-39 40-54 >55	0.9 (0.3–2.6) 0.1 (0.0–0.9) 0.3 (0.0–1.8)	Chi-squared test for independence produced non-significant results
		Chi-squared test for independence, past 30 day use of Salem Silver Label Cigarettes, by age	25-39 40-54 >55	2.1 (0.9–4.4) 1.2 (0.4–3.4) 0.0 (—)	Chi-squared test for independence produced non-significant results

Oliver, 2013	Data drawn from five studies	Current mean age; mixed-effects analysis of variance model, fitted with flavor (yes, no) as a fixed effect and a random effect for individual study; looks at current smokeless product (flavored/non-flavored)	 Mint-flavored user Non-flavored user	*Mean age (SD)* 32.5 (7.8) 37.3 (7.7)	**p<0.0001**
		Mean age of first dip; mixed-effects analysis of variance model, fitted with flavor (yes, no) as a fixed effect and a random effect for individual study; looks at current smokeless product (flavored/non-flavored)	 Mint-flavored user Non-flavored user	*Mean age (SD)* 16.3 (5.5) 16.8 (5.4)	p=0.358
		Mean age of daily regular use; mixed-effects analysis of variance model, fitted with flavor (yes, no) as a fixed effect and a random effect for individual study; looks at current smokeless product (flavored/non-flavored)	 Mint-flavored user Non-flavored user	*Mean age (SD)* 19.6 (5.7) 19.5 (5.9)	p=0.941
Soldz, 2003	Cigar Use Reasons Evaluation	Mean age of initiation by product; "robust test of the significant of mean differences in these ages among participants reporting lifetime use of both forms of tobacco"	 Kreteks Cigarettes	*Mean age (SD)* 14.08 (1.73) 12.64 (1.92)	Difference in mean (SE) = 1.69 (0.10). **p<0.001**
		Mean age of initiation by product; "robust test of the significant of mean differences in these ages among participants reporting lifetime use of both forms of tobacco"	 Kreteks Cigars	*Mean age (SD)* 14.08 (1.73) 13.47 (1.80)	Difference in mean (SE) = 0.67 (0.10). **p<0.001**
		Mean age of initiation by product; "robust test of the significant of mean differences in these ages among participants reporting lifetime use of both forms of tobacco"	 Kreteks Bidis	*Mean age (SD)* 14.08 (1.73) 13.90 (1.95)	Difference in mean (SE) = 0.10 (0.11). Difference in means not significant.
Vander Weg, 2008	Survey to assess alternative forms of tobacco use in young adult military recruits	Multivariable logistic regression; model includes gender, race/ethnicity, education, income and marital status; looks at current use of kreteks by age	<20 years old ≥20 years old Total	2.9% (2.6–3.2) 3.2% (2.8–3.6) 3.0 (2.7-3.2)	No significant association found
Villanti, 2013	Legacy Young Adult Cohort Study, Wave 2	Multivariable logistic regression of any current flavored tobacco use versus no flavored tobacco use; controls for gender, race/ethnicity, education and use of any menthol-brand tobacco product	18-24 25-34	N/R	*OR (95% CI)* **1.89 (1.14-3.11) (p<0.05)** 1.0 Referent
		Bivariate analysis of flavored tobacco product use by age	18-24 25-34	N/R	Younger age predicted flavored tobacco product use

*First author, year published

Supplementary Table 4. Flavored tobacco use, assessed by tobacco use status

Study ID*	Sample	Measures/Analysis	Age (years) or Population	% (95% CI)	Result
Oliver, 2013	Data drawn from five studies	Z-test comparing percent of users who started with a non-flavored product and now use a flavored product with percent of users who started with a flavored product and now use a non-flavored product	Users who started with a non-flavored product and now use a flavored product Users who started with a flavored product and now use a non-flavored product	51.3 35.6	Smokeless tobacco users who started by using non-flavored products were more likely to switch to mint-flavored products compared with the other way around (**p<.0001**).
		Z-test comparing percent of users who started with a non-flavored product and now use a non-flavored product with percent of users who started with a flavored product and now use a flavored product	Users who started with a non-flavored product and now use a non-flavored product Users who started with a flavored product and now use a flavored product	48.7 64.4	Smokeless tobacco users who started with a mint-flavored product were more likely to currently use a mint-flavored product compared with those who continue with non-flavored products (**p=.001**).
Soldz, 2003	Cigar Use Reasons Evaluation	Smoking initiation precedence among users of kreteks and cigars	Initiated with kreteks Initiated with cigars Initiated both at same age	17.8 (13.5-23.0) 49.7 (43.9-55.4) 32.5	N/A
		Smoking initiation precedence among users of kreteks and bidis	Initiated with kreteks Initiated with bidis Initiated both at same age	23.9 (17.8-31.2) 30.1 (24.0-37.1) 46	N/A
		Smoking initiation precedence among users of kreteks and cigarettes	Initiated with kreteks Initiated with cigarettes Initiated both at same age	7.5 (5.3-10.6) 71.7 (67.0-75.9) 20.8	N/A
		Current kretek use, by cigarette use	Current cigarette smokers Ever cigarette smokers	75.8 (67.0-82.8) 94.5 (88.9-97.3)	N/A
		Ever kretek use, by cigarette use	Current cigarette smokers Ever cigarette smokers	61.6 (56.6-66.5) 90.8 (87.8-93.2)	N/A
Vander Weg, 2005	Female military recruits	Simple odds ratio (unadjusted) looking at ever use of kreteks versus never use	Lifetime smokeless tobacco use Never smokeless tobacco use	N/R	*OR (95% CI)* 4.49 (3.79-5.31), **p<.001** 1.0 Referent
		Multivariate odds ratio (adjusted) looking at ever use of kreteks versus never use	Lifetime smokeless tobacco use Never smokeless tobacco use	N/R	*OR (95% CI)* 1.23 (1.01-1.49), **p=.04** 1.0 Referent
Vander Weg, 2008	Survey to assess alternative forms of tobacco use in young adult military recruits	Univariate logistic regression looking at use of kreteks	Cigarette smokers Non-cigarette smokers	N/R	*OR (99% CI)* 10.53 (8.41-13.20), **p<.001** 1.0 Referent
Villanti, 2013	Legacy Young Adult Cohort Study, Wave 2	Multivariable logistic regression of any current flavored tobacco use compared to no flavored tobacco use; controls for gender, race/ethnicity, and education	Any menthol use No menthol use	N/R	*OR (95% CI)* 2.28 (1.42-3.67), **p<0.001** 1.0 Referent

*First author, year published

Supplementary Table 5. Flavored tobacco use, overall or by other measures of prevalence

Study ID	Sample	Measures/Analysis	Age (years) or Population	% (95% CI)
CDC, 2003	2000 National Youth Tobacco Survey	Current use of kreteks	Middle school students (grades 6-8) High school students (grades 9-12)	2.1 (±0.4) 4.2 (±0.5)
		Current use of bidis*	Middle school students (grades 6-8) High school students (grades 9-12)	2.4 (±0.4) 4.1 (±0.4)
	2002 National Youth Tobacco Survey	Current use of kreteks	Middle school students (grades 6-8) High school students (grades 9-12)	2.0 (±0.3) 2.7 (±0.5)
		Current use of bidis*	Middle school students (grades 6-8) High school students (grades 9-12)	2.4 (±0.3) 2.6 (±0.5)
Malson, 2003	Local community volunteers	Ever use of kreteks	10 local community volunteers aged 19-46 who had previous smoked either clove or bidi cigarettes	40
Manning, 2009	US high school students	Smokes flavored cigarettes at least once in a while	Mean age 15.7	19
Oliver, 2013	Data drawn from five studies	Current mint smokeless tobacco use Ever mint smokeless tobacco use	Smokeless tobacco users aged 18-70	55.8 79.4
Regan, 2012	ConsumerStyles	Ever use of flavored cigarettes	Adults aged ≥18 years, nationally representative, who had heard of flavored cigarettes	27.4 (20.9-33.9)
		Ever use of flavored little cigars	Adults aged ≥18 years, nationally representative, who had heard of flavored cigars	31.5 (27.3-35.7)
Richter, 2008	Young adults in Texas and Tennessee	Ever use of hookah Ever use of kreteks	Smokers aged 18-22 who had tried or used nontraditional tobacco products	4 4
Soldz, 2003	Cigar Use Reasons Evaluation	Ever use of kreteks Current use of kreteks	Middle and high school students in Massachusetts	8.9 (7.8-10.1) 3.1 (2.4-3.9)
Soldz, 2005	Cigar Use Reasons Evaluation	Never use of kreteks Ever use of kreteks Current use of kreteks	Middle and high school students in Massachusetts who had heard of kreteks/cloves	70.7 20.1 8.1
Sutfin, 2014	Online survey, part of the Study to Prevent Alcohol-Related Consequences	Ever use of hookah	Students from eight colleges in North Carolina reporting ever smoking tobacco from a hookah	90
Vander Weg, 2008	Survey to assess alternative forms of tobacco use in young adult military recruits	Ever use of kreteks	Young adult military recruits	24.8
Villanti, 2013	Legacy Young Adult Cohort Study, Wave 2	Current use of cigars/cigarillos/bidis Current use of cigarettes Current use of cigars Current use of pipes Current use of chewing tobacco Current use of dip/snuff Current use of dissolvable tobacco Current use of hookah Current use of e-cigarettes	18-34 year olds, nationally representative sample	35% (95% CI: 25-47) 1% (95% CI: 0.00-0.02) 13% (95% CI: 0.08-0.21) 38% (95% CI: 18-63) 6% (95% CI: 2-18) 8% (95% CI: 3-21) 13% (95% CI: 2-49) 50% (95% CI: 36-64) 13% (95% CI: 6-27)

*First author, year published

Supplementary Table 6. Tobacco flavor preference, by product

Study ID	Type of Product	Measure	Result
Aljarrah, 2009	Hookah	Favorite hookah tobacco flavor	Mint (22%), combination of fruit flavors (19%), individual fruit flavors (most were less than 5%)
Blank, 2011	Hookah	Preferred waterpipe flavor	Apple/double apple (n = 8, 22%), mint (n=6, 16%), strawberry (n = 6, 16%), mango (n = 4, 11%), peach (n = 3, 8%), cherry (n = 2, 5%), watermelon (n = 2, 5%), grape (n=1, 3%), mixed fruit (n=1, 3%), orange (n=1, 3%), guava (n=1, 3%), rose (n=1, 3%), vanilla (n=1, 3%)
Cobb, 2011	Hookah	Preferred waterpipe flavor	Fruit flavors (e.g. mango, strawberry and melon) (n=46, 85%), mint (n=4, 7%), vanilla (n=2, 4%), X on the beach (n=1, 2%), jasmine (n=1, 2%)
Smith-Simone, 2008	Hookah	Favorite flavor of tobacco	"Apple" (n=31, 15.7%), "Other fruit" (n=75, 38.1%), "Mint" (n=18, 9.1%), "No particular flavor" (n=30, 15.2%), "Other flavor" (n=43, 21.8%)
Smith-Simone, 2008	Hookah	Type of tobacco favored	95.9% of participants favored "flavored" tobacco. 4.1% of participants favored "sometimes flavored or not flavored" tobacco
Blank, 2011	Cigars	Preferred Black & Mild cigarillo flavor	Regular (n=9, 56%), wine (n=7, 44%)
O'Connor, 2007	Cigarettes	Flavor choice	Seven Exotic Blends were offered. The most popular were: Twist (a citrus flavor) (n=7, 35%), Dark Mint (n=4, 20%), Warm Winter Toffee (n=3, 15%), Izmir Stinger (n=3, 15%), Mandarin Mint (n=2, 10%), and Crema (n=1, 1%). No significant differences in outcome measures were noted between Twist and the other flavored varieties (p values>.50)
Dawkins, 2012**	E-cigarettes	Preferred e-cigarette flavor	Participants could endorse more than one option. Favorite flavors among the entire sample were: tobacco (n=664, 53%), fruit (n=421, 33%), mint/menthol (n=357, 28%), chocolate/sweet flavor (n=231, 18%), coffee (n=167, 13%), other (n=196, 16%), vanilla (n=156, 12%), alcohol related (n=49, 4%) and flavorless (n=11, 1%). Current smokers and ex-smokers did not differ with respect to their flavor preference

*First author, year published

Supplementary Table 7. Perception of product

Response domain	Study ID*	Measure	Analytic Approach	Main Results
Attitudes and beliefs about product	Manning, 2009	Hedonic beliefs, measured with a multi-item scale assessing the likelihood that the brand is enjoyable, relaxing and good tasting	2 (descriptor: flavored vs. traditional) x2 (sensation seeking: high vs. low) x2 (school location) x3 (brand) repeated measures ANCOVA model, with brand as the only within-participants factor	There was a significant main effect of package descriptor (F (1, 215) =18.36, p,0.001). The flavor descriptors (M=3.50) led to more positive beliefs about the hedonic qualities of the brands than the traditional descriptors (M=2.64). This effect was qualified by a significant interaction between package descriptor and sensation seeking (F (1, 215) =10.17, p=0.002). Among lower sensation seekers, hedonic brand beliefs did not differ between the two package descriptor conditions (p=0.32; MTraditional=2.81, MFlavor=3.03). Within the higher sensation-seeking group, the flavor descriptors (M=3.98) led to more favorable hedonic brand beliefs than the traditional descriptors (M=2.47; p,0.001).
		Brand attitude, measured with a multi-item scale assessing perceptions from the point of view of another person (such as an acquaintance or friend)		There was a significant interaction between package descriptor and sensation seeking (F (1, 211)=10.47, p<.001). A contrast revealed a marginally significant effect (p=0.10) of the cigarette descriptor within the lower sensation-seekers' condition such that attitudes were more favorable among those exposed to the traditional descriptors (M=2.91) than the flavor descriptors (M=2.53). A second contrast revealed a significant effect (p=0.003) of the descriptor manipulation among higher sensation seekers with brand attitudes being more favorable among those exposed to the flavor than the traditional descriptors (MTraditional=2.40, MFlavor=3.44).
	Soldz, 2005	Kreteks taste good	Contingency table techniques	Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status: No use 2.0% (95% CI: 1.3-2.9); Lifetime use 69.6% (95% CI: 64.1-74.6); Current use 86.4% (95% CI: 79.1-91.4) Endorsing this item was found to predict use of kreteks (OR=98.77, 95% CI: 35.19-277.23).
		Kreteks smells good		Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status: No use 9.1% (95% CI: 7.4-11.1); Lifetime use 67.6% (95% CI: 62.2-72.6); Current use 81.6% (95% CI: 73.9-87.4)
		Kreteks are more natural than cigarettes		Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status: No use 7.9% (95% CI: 6.5-9.6); Lifetime use 34.2% (95% CI: 29.4-39.4); Current use 54% (95% CI: 45.1-62.7)
Future use intentions	Ashare, 2009	Relationship between positive expectancies and willingness to try flavored and non-flavored cigarettes	Logistic regression analysis of "Intention to Try" as a function of smoking status, positive expectancies and negative expectancies	Across all brands, positive expectancies significantly predicted the likelihood one would try a brand. Odds ratios indicated that as positive expectancies increased one point, participants were 1.6 (95% CI: 0.6-1.0, p<0.01, for Salem Regular), 2 (95% CI: 1.4-2.7, p<0.001, for Salem Silver), 1.8 (95% CI: 1.3-2.5, p<0.001, for Camel Light), and 2.4 (95% CI: 1.7-3.4, p<0.001, for Camel Exotic) times more willing to try that particular brand.
		Relationship between negative expectancies and intention to try flavored and non-flavored cigarette brands		Negative expectancies were not reliably related to intention to try Camel Light, Camel Exotic, or Salem Silver. Negative expectancies predicted a modest reduction in intention to try Salem Regulars (OR 0.08, 95% CI: 0.6-1.0, p<0.05).
	Manning, 2009	Trial intentions, measured with a single item, a scale anchored by "very unlikely" (1) and "very likely" (7) that asked participants "In the future, how likely is it that your friends with try [brand name] cigarettes?	2 (descriptor: flavored vs. traditional) x2 (sensation seeking: high vs. low) x2 (school location) x3 (brand) repeated measures ANCOVA model, with brand as the only within-participants factor	There was a significant effect for an interaction between package descriptor and sensation seeking (F(1, 215)=8.92, p=0.003). In assessing the interaction, a contrast revealed that among lower sensation seekers trial intentions were marginally greater in the traditional descriptor condition (M=3.19) than the flavor descriptor condition (M=2.77; p=0.07). Among the higher sensation seekers, the flavored descriptors (M=3.36) led to higher trial intentions than the traditional descriptors (M=2.53; p=0.01).

	Pepper, 2013	Participants were asked: "If one of your best friends were to offer you an e-cigarette, would you try it?" and "If one of your best friends were to offer you a flavored e-cigarette (chocolate, mint, apple, etc.), would you try it?"	Logistic regression	13.2% of participants answered that they were "probably" or "definitely" willing to try both types of e-cigarettes. 3.9% of participants answered that they were "probably" or "definitely" willing to try the flavored e-cigarettes, but not the e-cigarettes that were not specifically described as "flavored." 1.3% answered that they were "probably" or "definitely" willing to try the e-cigarettes that were not specifically described as "flavored," but not the flavored e-cigarettes. The difference between the number of participants willing to try a flavored e-cigarette versus the number willing to try an e-cigarette that was not described as "flavored" did not significantly differ (p=.15).
	Soldz, 2005	Kreteks are something different to try	Contingency table techniques	Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status: No use 10.8% (95% CI: 9.0-12.8); Lifetime use 60.6% (95% CI 54.7-66.2); Current Use 79.0% (95% CI: 70.5-85.6). Endorsing this item was found to predict use (OR=3.15, 95% CI: 1.63-6.06).
Outcome expectancies	Asahre, 2007	Positive expectancies around flavored (Salem Silver, Camel Exotics) cigarette brands compared to non-flavored (Salem Regular, Camel Lights) cigarette brands Negative expectancies around flavored and non-flavored cigarette brands; intention to try flavored and non-flavored cigarette brands.	Repeated measures ANOVAs (3 Smoking Status x 4 Brand Types). Smoking status was a between-subjects factor and brand was a within-subjects factor	Positive expectancies were influenced by flavor, with higher positive expectancies for Salem Silver compared to Salem Regular across smoking status (brand F(1,421)=155.6, p<0.001, partial η2 =0.27; Salem Silver vs. Regular x Smoking Status, F<1). Similarly, Camel Exotics produced greater positive expectancies than did Camel Lights (brand F(1,421)=38.4, p<0.001, partial η2 =0.08). This difference was at least as strong among susceptible/experimenters (M=0.45, F(1,109)=30.6, p<0.01, partial η2 =0.22) as it was for regular smokers (M=0.43, F(1,63)=8.6, p<0.0, partial η2 =0.12), with only a modest effect among committed nonsmokers (M=0.14, F(1,249)=5.4, p<0.05, partial η2 =0.02; Camel Exotic vs. Light x Smoking Status F(2,421)=4.9, p<0.01, partial η2=0.02) Across all groups, Camel Lights were rated more negatively than were Camel Exotics (F(1,421)=8.2, p<0.01, partial η2 =0.02), an effect that did not reliably vary by smoking status (F(2,421)=2.0, p=0.11). For Salem, the non-flavored product was also rated more negatively than the flavored product; however, this effect was reliable among the nonsmoker and susceptible/experimenter groups (F(1,249)=37.6, pb0.01, partial η2=0.13 and F(1,109)=10.1, p<0.01, partial η2 =0.09, respectively; Salem vs. Salem Silver x Smoking Status F(2, 421)=3.3, p<0.05), but not the regular smokers (F<1).
	Soldz, 2005	Kreteks give you a good buzz	Contingency table techniques	Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status, from No use 2.3% (95% CI: 1.5-3.4); Lifetime use 21.4% (95% CI: 17.1-26.3): Current use 33.1% (95% CI: 24.6-42.8)
Risk Perception	Soldz, 2005	Kreteks are not as bad for you as cigarettes	Contingency table techniques	Endorsement of this statement increased monotonically and significantly (p<0.001) by smoking status, from no use (3.6%, 2.6-4.9) to lifetime use (15.1%, 11.3-19.9) to past month use (28.8%, 21.2-37.8).
Social acceptability	N/R			

*First author, year published

Supplementary Table 8. Response to product

Response domain	Study ID (first author, year published)	Measure		Comparators*			Significance
Nicotine reward	Malson, 2002		**Irie Bidi (strawberry)**	**American Spirit ®**	**Sher Bidi**	**Own Brand**	**F-test**
		High in nicotine	4.7 ± 1.8	5.2 ± 1.7	4.2 ± 1.9	5.2 ± 1.1	No differences
Taste/sensory effects	Malson, 2002		**Irie Bidi (strawberry)**	**American Spirit ®**	**Sher Bidi**	**Own Brand**	**F-test**
		Liking	4.8 ± 0.9[a]	3.1 ± 2.2[a]	3.9 ± 1.6	6.3 ± 0.7	F[3,27] = 11.23, p<0.001
		Satisfaction (DSQ)	4.8 ± 1.3[a]	3.1 ± 2.2[a]	3.7 ± 1.7[a]	6.3 ± 0.7	F[3,27] = 10.68, p<0.001
		Satisfaction (maximum=14)[b] (CES)	9.2 ± 2.4[a]	6.1 ± 4.3[a]	8.4 ± 3.4[a]	12.6 ± 1.2	F[3,27] = 9.11, p<0.001
		Enjoyment of sensations in throat and chest	4.7 ± 1.1	2.8 ± 1.8[a]	3.7 ± 1.8[a]	5.7 ± 0.1	F[3,27] = 7.16, p<0.001
		Strength (maximum=35)[b]	21.4 ± 5.4	22.3 ± 9.3	18.6 ± 5.9[a]	24.6 ± 7.4	Not reported
		Craving relief	4.7 ± 1.8[a]	5.4 ± 2.0	4.1 ± 2.0[a]	6.0 ± 0.9	F[3,27] = 3.88, p<0.05
	Malson, 2003		**Clove Cigarette**			**Own Brand**	**Dependent t-test**
		Liking of taste	6.1±0.5			4.8±0.4	t(9)=2.25, P<.05
		Reduction in hunger for food	2.1±1.5			3.0±1.9	t(9)=2.1, P<.10
	O'Connor, 2007		**Exotic**	**Light**			**F-test**
		Liking	3.0 (0.2)	4.5 (0.2)			F[1,18] = 3.8, p=.07
		Satisfaction (DSQ)	4.2 (0.3)	4.2 (0.3)			F[1,18] = 0.3, p=.88
		Strength (maximum=35)[b]	19.1 (1.)	18.3 (1.0)			F[1,18] = 0.8, p=.40
		Harshness/irritation/strength scale[b]					F[1,18] = 11.9, p=.003
		Lights smoked first	12.7 (1.0)	9.1 (1.0)			
		Exotics smoked first	9.2 (1.0)	10.6 (1.0)			
Conditional cue reactivity	N/R						
Affective and behavioral response	Malson, 2002		**Irie Bidi (strawberry)**	**American Spirit ®**	**Sher Bidi**	**Own Brand**	**F-test**
		Psychological reward (maximum=35)[b]	17.5 ± 5.4	13.2 ± 6.5	14.3 ± 7.3	19.3 ± 6.5	F[3,27] = 2.86, p=0.056
Personal acceptability	Malson, 2002		**Irie Bidi (strawberry)**	**American Spirit ®**	**Sher Bidi**	**Own Brand**	**F-test**
		Similar	1.9 ± 1.1[a]	2.1 ± 1.3[a]	1.6 ± 1.0[a]	7.0 ± 0.0	F[3,27] = 84.84, p<0.001
		Aversion (maximum=14)[b]	6.1 ± 3.5	6.0 ± 2.5	4.3 ± 2.1	3.5 ± 1.8	No differences
	Malson, 2003		**Clove Cigarette**			**Own Brand**	**Dependent t-test**
		Different from own brand	1.9±1.2			6.5±1.3	t(9)=10.2, P<.001
	O'Connor, 2007		**Exotic**	**Light**			**F-test**
		Similar	2.8 (0.3)	4.2 (0.4)			F[1,18]=5.8, p=.03

Results from O'Connor et al. are reported as mean (standard error); results from Malson et al. (2002, 2003) are reported at mean (±standard deviation).
Only significant results are presented for Malson, 2003. The authors of this study stated that "[a]ll other differences in subjective items were not statistically significant" [28]; however, they do not confirm that all DSQ and CES items were assessed.
Unless otherwise noted, all items were anchored on a seven-point Likert scale.
*For all comparators, own brand = conventional, nonfiltered cigarettes
[a] Indicates significant difference from own brand (p<0.05, Dunnett's test).
[b] Indicates collapsed values

Supplementary Table 9. Risk of bias, non-qualitative studies*

StudyID**	Aliarrah, 2009	CDC, 2003	Ashare, 2007	Blank, 2011	Blank, 2011	Cobb, 2011	Dawkins, 2013	King, 2013	Klein, 2007	Malson, 2002	Malson, 2003	Manning, 2009	O'Connor, 2007	Oliver, 2013	Pepper, 2013	Regan, 2012	Smith-Simone, 2008	Soldz, 2003	Soldz, 2005	Suftin, 2014	Vander Weg, 2005	Vander Weg, 2008	Villanti, 2013
Inclusion/exclusion criteria	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	N/A	✔	✔	X	✔	✔	✔	✔	✔	✔
Recruitment strategy	✔	✔	?	✔	?	✔	✔	X	✔	✔	✔	✔	?	N/A	✔	✔	X	X	X	✔	✔	✔	✔
Selection of the comparison group	N/A	✔	✔	✔	✔	✔	N/A	N/A	N/A	N/A	N/A	✔	✔	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Outcome assessor blinding	N/A	N/A	N/A	N/A	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	?	N/A	N/A	N/A	N/A	N/A	N/A	✔	N/A	N/A	N/A
Valid and reliable measures	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Measures implemented consistently	X	✔	✔	✔	✔	✔	X	✔	✔	✔	✔	?	X	N/A	✔	✔	X	✔	✔	X	✔	?	✔
Length of follow-up	N/A	N/A	N/A	✔	N/A	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Loss to follow-up	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Primary outcomes missing	✔	✔	X	✔	✔	✔	✔	✔	✔	✔	✔	✔	?	✔	✔	✔	✔	✔	✔	✔	✔	X	✔
Results believable	?	✔	?	✔	✔	✔	?	✔	✔	?	✔	✔	X	?	?	✔	✔	✔	✔	✔	✔	✔	✔
Attempt to balance the allocation	N/A	N/A	✔	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Confounding variables	N/A	N/A	✔	✔	✔	✔	N/A	N/A	✔	N/A	N/A	✔	X	✔	✔	N/A	N/A	N/A	N/A	N/A	✔	N/A	N/A
Analytic techniques	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	?	✔	✔	?	✔	✔	✔	✔	✔	✔
Allocation sequence generation	N/A	N/A	?	?	?	N/A	N/A	N/A	N/A	N/A	N/A	?	?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Allocation concealment	N/A	N/A	N/A	N/A	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Knowledge of the allocated intervention prevented	N/A	N/A	N/A	N/A	✔	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*A checkmark indicates that the study was not susceptible to bias. An "X" indicates that the study was susceptible to bias. A question mark indicates that it was unclear if the study was susceptible to bias. "N/A" indicates that this question was not applicable for the study.
**First author, year published

Supplementary Table 10. Risk of bias, qualitative studies*

StudyID**	Choi, 2012	Griffiths, 2011	Lavo, 2004	Liu, 2012	Richter, 2008	Sifaneck, 2005
Inclusion/exclusion criteria	✔	?	✔	✔	✔	?
Recruitment strategy	X	X	?	X	X	X
Selection of the comparison group	N/A	N/A	N/A	✔	✔	N/A
Outcome assessor blinding	N/A	N/A	N/A	N/A	N/A	N/A
Valid and reliable measures	?	?	?	?	?	?
Measures implemented consistently	✔	✔	✔	?	?	✔
Length of follow-up	N/A	N/A	N/A	N/A	N/A	N/A
Loss to follow-up	N/A	N/A	N/A	N/A	N/A	N/A
Primary outcomes missing	✔	✔	✔	✔	✔	X
Results believable	✔	✔	✔	X	?	?
Attempt to balance the allocation	N/A	N/A	N/A	✔	X	N/A
Confounding variables	N/A	N/A	N/A	N/A	N/A	N/A
Analytic techniques	✔	✔	✔	X	✔	?
Data transcribed verbatim	✔	✔	✔	✔	✔	✔
Questions predefined	✔	✔	✔	✔	✔	?
Facilitator/interviewers trained	✔	?	✔	✔	✔	?
Saturation	X	X	X	X	X	X
Research themes	✔	✔	✔	✔	✔	X
Analysis by more than one assessor	✔	?	X	✔	✔	?
Participant answers reviewed	?	?	✔	?	?	?
Sequences from data presented	✔	✔	✔	✔	✔	✔

*A checkmark indicates that the study was not susceptible to bias. An "X" indicates that the study was susceptible to bias. A question mark indicates that it was unclear if the study was susceptible to bias. "N/A" indicates that this question was not applicable for the study.
**First author, year published

Huang et al. (2017) Supplementary Table

Supplementary Table 1. Main results of included studies

Study	Study design	Measures/analysis	Results
E-cigarettes			
Amato, 2015	Cross-sectional, probability sample	Descriptive statistics were used to examine reasons for e-cigarette use.	A greater proportion of current e-cigarette users cited "come in flavors other than menthol" as a reason for their e-cigarette use than past users (55.5% vs. 25.0%).
Berg, 2016	Cross-sectional, convenience sample	ANOVAs were used to compare continuous variables across groups, and Chi-square tests were used to compare categorical variables.	32% of nonusers included ‘‘they come in appealing flavors’’ as a reason for possible future e-cigarette use. 39% of current smokers, who are non-e-cigarette users, chose “they come in appealing flavors” as a reason for possible e-cigarette use; this is compared to <31% of nonsmokers and former smokers, p<0.001. 60.2% of current e-cigarette users chose “they come in appealing flavors” as a reason for e-cigarette use; 59.5% of those same users chose “I like experimenting with various flavors” as a reason for e-cigarette use. 69.7% of never cigarette smokers who use e-cigarettes chose “they come in appealing flavors” as a reason for e-cigarette use; 61.4% of former cigarette smokers who use e-cigarettes chose “I like experimenting with various flavors” as a reason for e-cigarette use. 20.3% of former e-cigarette users reported no recent use of e-cigarettes because they ‘‘don’t like the flavor(s)’’.
Czoli, 2015	Cross-sectional, convenience sample	Multinomial logit regression was used to analyze the effect of attributes on consumer choice for each outcome.	Participants were significantly more interested in trying ecigarettes with cherry (p<0.0001, r=0.2) and menthol (p=0.01, r=0.1) flavors Younger smokers expressed interest in trying e-cigarettes with a preference for products with cherry flavor (p<.001, r=0.2) while younger nonsmokers indicated interest in trying cherry

			(p<.0001, r=0.3), menthol (p<.0001, r=0.2) and coffee flavor (p<.001, r=0.2); Older smokers indicated greater interest in trying tobacco-flavoured e-cigarettes (p<0.0001, r=0.6). E-cigarettes with the following characteristics were perceived as less harmful and greater quit efficacy : menthol (p<0.0001, r=0.6; p<0.0001, r=0.2) and coffee flavors (p<0.0001, r=0.3; p<0.001, r=0.2) Younger non-smokers were more likely to perceive coffee-flavoured (p=0.02, r=0.1) e-cigarettes as less harmful while younger smokers held these beliefs about products with cherry flavour (p=0.03, r=0.1); Older smokers perceived products with tobacco flavour (p<0.001, r=0.2) as less harmful. Compared to other attributes, flavor accounted for 24% of the relative importance on intention to try, 36% for perceptions of reduced product harm, and 25% on perceptions of enhanced product quit efficacy
Etter, 2010	Cross-sectional, convenience sample	Open-ended questions about the most positive and negative points about e-cigarettes were analyzed.	The most frequently cited positive feature of e-cigarettes was that respondents liked the taste and variety of flavors (18% of total open-ended comments).
Farsalinos, 2013	Cross-sectional, convenience sample	X^2 tests compared categorical variables (e.g., type of e-cigarette flavors regularly used) between current and former smokers. A stepwise binary logistic regression analysis was used with smoking status (former vs current smoker) as the independent variable and age,	More current smokers were using tobacco flavors compared to former smokers (X^2=14.6, p<.001), while more former smokers were using fruit (X^2=14.0, p<.001) and sweet flavors (X^2=21.8, p<.001). The average score for importance of flavors variability in reducing or quitting smoking was 4 (“very important”) on a 5-point scale. 39.7% of participants reported that restricting variability of flavors would make reducing or completely substituting

		gender, education level, smoking duration, number of flavorings used regularly, and e-cigarette consumption as covariates.	smoking less likely. Binary logistic regression analysis showed that number of flavors regularly used (β=0.089, p=0.038) were associated with complete smoking among dedicated long-term users.
Farsalinos, 2014	Cross-sectional, convenience sample	Descriptive statistics examined reasons for initiating e-cigarette use.	Initiating e-cigarette use to enjoy the variability of flavors in e-cigarettes was ranked as 3 on a 5-point scale from 1 (not important) to 5 (most important).
Ford, 2016	Cross-sectional, probability sample	Paired t-tests were run on weighted data to produce mean scores; the Friedman test was used on ordinal data, then post hoc tests were conducted using the Wilcoxon signed rank test	Perceptions of harm from the different flavors ranged from a mean of 3.00 (SD = 1.35) for candy floss flavor to 3.06 (SD = 1.29) for cherry, 3.47 (SD = 1.22) for coffee and 3.99 (SD = 1.14) for tobacco flavor. Perceptions of harm differed depending on the flavor, v2 (4) = 851.59, p<0.001. Post hoc analysis showed that, when compared against perceptions of harm of e-cigarettes in general, tobacco flavor e-cigarettes were perceived as being more harmful (p<0.001) while cherry and candy floss flavors were each perceived as less harmful (p<0.001). Coffee flavor e-cigarettes were perceived as having the same level of harm as e-cigarettes in general. Perceptions of likelihood of an adult smoker using each differed depending on the flavor, v2 (3) = 153.9, p <0.001 as did perceptions of likelihood of a never smoker of their age v2 (3) = 879.01, p<0.001. Post hoc analysis showed that, when compared with tobacco flavor e-cigarettes, adult smokers who were trying to give up smoking were perceived to be less likely to use cherry, candy floss or coffee flavors (p<0.001). Conversely, a never smoker of their age was perceived to be more likely to try cherry (p<0.001), candy floss (p<0.001) or coffee flavor (p<0.01) than a tobacco flavor e-cigarette.

			An adult smoker was perceived to be more likely than a never smoker of their age to use tobacco ($p<0.001$) and coffee ($p<0.001$) flavors whereas a never smoker of their age was perceived to be more likely than an adult smoker to try candy floss ($p<0.001$) and cherry ($p<0.01$) flavors.
Kong, 2014	Cross-sectional, convenience sample	X^2 tests evaluated school level differences (middle school, high school, college) on all variables. Multinomial logistic regression analyses evaluated the extent to which reasons for e-cigarette experimentation differed based on cigarette smoking status.	43.8% of respondents reported the availability of flavors as a reason for experimentation with e-cigarettes. School level differences were observed ($X^2(2,N=1,157)=18.63$, $p\leq.001$), with high school students more likely to experiment with e-cigarettes because of appealing flavors compared to college students (47.0% vs 32.8%, $X^2(1,N=1,116)=13.61$, $p\leq.001$).
Krishnan-Sarin, 2014	Cross-sectional, convenience sample	Descriptive statistics explored flavors of e-cigarettes that had been tried and preferred.	Most lifetime e-cigarette users in middle school and high school, across cigarette smoking status, reported that they had tried and preferred sweet flavors compared to menthol and tobacco flavors.
Nonnemaker, 2015	Cross-sectional, convenience sample	Calculated coefficients and corresponding 95% CIs for a series of multivariate linear regression models; regressed indicators for each characteristic on respondents' reported willingness to pay for an e-cigarette with a specific set of attributes	Among the full sample, losing the attribute "coming in flavors" significantly reduced the price respondents were willing to pay for an e-cigarette ($p<0.05$). Among cigarette-only users, losing the attribute "coming in flavors" significantly reduced the price respondents were willing to pay for an e-cigarette ($p<.01$); this relationship was not significant for dual users.
Pepper, 2013	Cross-sectional, national probability sample	Logistic regression examined willingness to try any kind of e-cigarette (plain, flavored, or both).	The same proportion of respondents were willing to try plain e-cigarettes or to try flavored e-cigarettes ($p=.15$).
Pepper, 2014	Cross-sectional,	Descriptive statistics assessed	Less than 10% of respondents reported starting e-cigarette

	national probability sample and convenience sample	reasons for first trying e-cigarettes.	use because “e-cigarettes come in flavors they like.”
Shiffman, 2015	Cross-sectional, convenience sample	Comparisons of teen and adult respondents’ ratings of their interest by flavor and comparisons of ratings by flavor within the adult sample by e-cigarette use status (recent user, past user, never user).	Adult smokers’ e-cigarette ratings (overall mean=1.73±1.0 on a 0-10 scale) were significantly higher (p<.0001) than nonsmoking teens’ (overall mean=0.41±0.14). For each of the 15 flavors, adult smokers’ interest in trying e-cigarettes was significantly higher than nonsmoking teens’ interest (all p values<.05, most p values<.0001). Adults who were recent (past 30-day) e-cigarette users had the highest overall e-cigarette interest (mean=3.19±0.21), followed by past users (mean=1.62±0.17), and then never users (mean=1.08±0.15), and comparisons between groups were all significant (p values <.0001).
Shiplo, 2015	Cross-sectional, convenience sample	Logistic regression models examined factors associated with use of flavors	Among current e-cigarette users, a common reason for use was taste (32.3% of younger non-smokers, 18.4% of younger smokers, 6.5% of older smokers). Use of flavored e-cigarettes varied by smoking status ($\chi 2=74.66$, p<0.001). It was less common for older smokers to use flavoured e-cigarettes compared to younger smokers (OR=0.36, 95% CI 0.25 to 0.51; p<0.001). Younger non-smokers were less likely to try a flavored e-cigarette than younger smokers (OR=0.13, 95% CI 0.08 to 0.22; p<0.001) and older smokers (OR=0.36, 95% CI 0.22 to 0.62; p<0.001).
Tackett, 2015	Cross-sectional, convenience sample	Descriptive statistics examined preferred e-liquid flavors. Logistic regression, controlling for age and sex, was performed to assess associations between	Non-traditional flavors, such as fruity (46.7%; e.g., strawberry, blueberry) and candy/nuts (12.6%; e.g., cotton candy, SweetTart, Hazelnut, Almond) e-liquids were the most preferred flavors. People who reported using non-tobacco and non-menthol

		flavor (traditional tobacco/menthol vs non-traditional e.g., fruity, coffee, candy) on participants' biochemically verified smoking status.	flavors were more likely to have quit smoking (OR=2.626, 95% CI=1.133-6.085, p=.024).
Vasiljevic, 2015	Cross-sectional, convenience sample	Mann-Whitney tests and logistic regression were used to assess exposure to advertisements and increase in ratings of appeal, interest in buying and trying e-cigarettes. Logistic regression was also used to examine exposure to advertisements and effects on susceptibility to smoking.	Exposure to the flavored e-cigarette adverts increased the appeal of e-cigarette adverts: Mann-Whitney test, U=10 056.500, Z=−2.777, p=0.005, whereby those who saw the flavored e-cigarette adverts rated them as more appealing (mean rank=170.92) than those who saw the non-flavored e-cigarette adverts (mean rank=142.45). Exposure to the flavored e-cigarette adverts increased interest in buying and trying e-cigarettes: Mann-Whitney test, U=9140.000, Z=−3.949, p<0.001, whereby those who saw the flavored e-cigarette adverts expressed greater interest in buying and trying e-cigarettes (mean rank=176.44) than those who saw the non-flavored e-cigarette adverts (mean rank=136.26).
Yingst, 2015	Cross-sectional, convenience sample	T-tests and X^2 tests were used to identify differences between current first generation device (FGD) and advanced generation device (AGD) users. Descriptive statistics examined how respondents transitioned between devices.	Participants using an AGD were more likely to rate variety of flavor choices as important (FGD 54.6% vs AGD 94.9%, p<.0001). Most (58.9%) e-cigarette users began use with a FGD, and of these users 63.7% subsequently transitioned to current use of an AGD. Among users who began use with an AGD (41.1%), only 5.7% transitioned to a FGD.
Cigarettes			
Agaku, 2014	Cross-sectional, probability sample	Multiple logistic regression models were fitted to assess subgroup differences in	1.4% of current and former cigarette smokers indicated that a specific, fruity or spicy flavor in cigarettes was an important factor in their initial smoking.

		receptivity to various cigarette design and marketing features related to initial smoking (current and former smokers) and brand choice (current smokers), controlling for sex, age, region of residence, socioeconomic status, residence type, and age at initiation of regular smoking.	Respondents aged ≥55 were less likely to report sweet, fruity or spicy flavors as being important to their initial smoking than respondents aged 15-24 (AOR=0.38; 95% CI: 0.20, 0.73). Respondents in Eastern Europe were less likely to report sweet, fruity or spicy flavors as being important to their initial smoking than respondents in Western Europe (AOR=0.59; 95% CI: 0.35, 0.98). 33% of current smokers reported a specific sweet, menthol, fruity or spicy flavor as being important in their cigarette brand choice. Female smokers were more likely to choose a cigarette brand based on specific tastes such as menthol or spicy, fruity or sweet flavors (AOR=1.33; 95% CI: 1.14, 1.56).
Ashare, 2007	Cross-sectional, convenience sample	Repeated-measures ANOVAs were used to examine positive and negative expectancies of Camel Exotic cigarettes (flavored) and Camel Lights cigarettes (non-flavored). Logistic regression was used to examine intention to try a brand (willing or not willing) as the outcome variable.	Camel Exotics produced greater positive expectancies than did Camel Lights (brand $F(1,421)=38.4$, $p<0.001$, partial $n^2=0.08$), with the strongest difference among susceptible/experimenters ($M=0.45$, $F(1,109)=30.6$, $p<0.01$, partial $n^2=0.22$). Camel Lights were rated more negatively than were Camel Exotics ($F(1,421)=8.2$, $p<0.01$, partial $n^2=0.02$) across nonsmokers, susceptible/experimenters, and regular smokers. Participants were 2.4 times more willing to try Camel Exotics as positive expectancies increased by 1 point. Negative expectancies were not reliably related to intention to try Camel Exotics.
Doxey, 2011	Cross-sectional, convenience	Regression models were used to examine the effect of	No significant differences in tar delivery and health risk ratings were observed for cigarette packs with and without flavor

	sample	experimental condition (i.e., fully branded female cigarette brands, same brands without descriptors, same brands without brand imagery or descriptors ("plain packs"), and fully branded non-female packs) for 3 primary outcomes: brand ratings, smoker trait ratings, and beliefs about smoking. Models were adjusted for age, education, income, self-esteem, smoking status, and weight concerns.	descriptors. Participants rated Capri Cherry and Capri Vanilla cigarette packs as better tasting than packs without flavor descriptors ($p<.05$). Participants rated Capri Vanilla cigarette packs as more appealing than packs without flavor descriptors ($p<.05$).
Hammond, 2011	Cross-sectional, convenience sample	Logistic regression of appeal, taste, tar, and health risk index variables examined differences across experimental conditions (i.e., fully branded female cigarette packs, the same packs without descriptor words, the same packs without brand imagery or descriptors ("plain packs") and branded non-female brands). Models were adjusted for age, education, income, ethnicity, smoking status, and weight concerns.	Participants rated Capri Cherry cigarette packs as better tasting ($p<.05$) compared to packs without flavor descriptors.
Hammond, 2013	Cross-sectional, convenience sample	Logistic regression of appeal, taste, tar, and health risk index variables examined differences across experimental conditions	Participants rated Capri Cherry and Capri Vanilla cigarette packs as having less health risk ($p<.05$) and lower tar delivery ($p<.05$) compared to packs without flavor descriptors.

		(i.e., fully branded female cigarette packs, the same packs without descriptor words, the same packs without brand imagery or descriptors ("plain packs") and branded non-female brands). Models were adjusted for age, education, income, ethnicity, smoking status, and weight concerns.	Participants rated Capri Cherry and Capri Vanilla cigarette packs as more appealing ($p<.05$) and better tasting ($p<.05$) compared to packs without flavor descriptors.
Kaleta, 2014	Cross-sectional, probability sample	X^2 tests used to compare trends in intention to quit smoking among current flavored and non-flavored cigarette smokers.	Among women, the prevalence of flavored cigarette use increased with declining likelihood to quit (p for trend <.02). Over 30% of female smokers who did not intend to quit used flavored cigarettes, a higher percentage than those who did intend to quit. Only 8% of male smokers who did not intend to quit used flavored cigarettes, a lower proportion than male flavored cigarette smokers who did intend to quit (p for trend <.04).
Manning, 2009	Cross-sectional, convenience sample	2 (descriptor: flavored vs. traditional) x2 (sensation seeking: high vs. low) x2 (school location) x3 (cigarette brand) repeated measures ANCOVA model.	Flavor descriptors led to more positive beliefs about the hedonic qualities of brands than the traditional descriptors ($F(1,215)=18.36$, $p<0.001$). A significant effect was observed for the interaction between package descriptor and sensation seeking ($F(1,211)=10.47$, $p<0.001$). A contrast revealed a significant effect ($p=0.003$) of the descriptor manipulation among higher sensation seekers with brand attitudes being more favorable among those exposed to the flavor rather than the traditional descriptors. A significant interaction was observed between package descriptor and sensation seeking ($F(1,215)=8.92$, $p=0.003$) in which flavored descriptors led to higher trial intentions than

			the traditional descriptors (p=0.01).
O'Connor, 2007	Cross-sectional, convenience sample	2 (variety: flavored Camel Exotic or non-flavored Camel Light cigarettes) x2 (order) mixed model ANOVA.	Neither mean liking/satisfaction nor harshness/irritation ratings differed significantly between Camel Light (non-flavored) and Camel Exotic (flavored) cigarettes.
Thrasher, 2015	Longitudinal, convenience sample	Smokers identified the brand family for the cigarettes that they usually or currently smoked, after which they were shown images of cigarette packages for brand family varieties on the market at the time of the survey. The brand varieties were coded into 3 categories of flavor (i.e., regular non-flavored cigarettes; flavored cigarettes, no capsule; flavor capsule) based on analysis of descriptive words in the variety names (e.g., menthol; cool; crush).	Smokers' preference for flavor capsule brands significantly increased over time in Mexico (6% in 2012 to 14% in 2014) and Australia (0.1% to 3%). In the US, preference for flavor capsule brands did not change significantly over time (roughly 4% at each wave). Younger ages were most consistently associated with preferring flavor capsule brands across countries. In Mexico ($p<.001$) and the US ($p<.05$), women were more likely to prefer flavor capsule brands. In Australia, smokers with lower HSI (heaviness of smoking index) were more likely to prefer flavor capsule brands ($p<.001$).
White, 2012	Cross-sectional, convenience sample	Logistic regression models were used to examine the effect of the experimental conditions (standard branded packages, same packs without brand imagery ("plain packaging") and same packs without brand imagery or descriptors (e.g., flavors)). Linear regression models were used to examine the effect of the experimental conditions on the appeal, taste, and health	Plain (i.e., no brand imagery) cigarette packages with descriptors were rated as significantly more appealing ($\beta=0.89$, $p=0.002$) and given higher taste ratings than plain packages without descriptors ($\beta=1.60$, $p< 0.001$). Linear regression indicated no significant main effect of condition (i.e., branded vs. plain vs. plain-no descriptors) on perceptions of health risk ($F=1.6$, $p=0.207$).

		risk index variables. Models were adjusted for age, education, ethnicity, and smoking status.	
Little cigars, cigarillos, and cigars			
Delnevo, 2015	Cross-sectional, nationally representative sample	Logistic regression was used to model preference for a brand that is flavored (brand includes flavors/brand does not include flavors). Multiple linear regression was used to model the percent flavored market share of the respondent's preferred cigar brand.	Reporting a usual brand that makes flavored cigars decreased significantly with age, as 95.1% of 12-17 year olds reported a usual brand that makes flavored cigars compared with 63.2% of cigar smokers aged 35+. Females reported usual cigar brands for which a higher proportion is flavored (46.4%) more often than males (35.8%). The usual brand of black smokers had a higher flavored market share (43.9%) than those brands reported by whites (36.3%) and Hispanics (36.7%). Brands that offered flavored varieties were preferred more by cigar smokers were who current cigarette smokers (vs. those who do not smoke cigarettes) (AOR=2.5, 95% CI=1.9-3.2). Having a usual brand with a largely flavored market share was highest among 12-17 year olds and decreased with age.
Leatherdale, 2011	Cross-sectional, nationally representative sample	Logistic regression models were used to examine factors associated with cigarillo ever and current use and cigar ever and current use. Models for ever use excluded the measure of ever used flavored tobacco since they may represent the same product.	Respondents who reported ever using flavored tobacco were more likely to currently use cigarillos or little cigars (OR=5.62, 95% CI: 5.00,6.33; p<.001) or currently use cigars (OR=4.28, 95% CI: 3.71, 4.95; p<.001) compared to respondents who have never used flavored tobacco.
Yates, 2014	Cross-sectional, convenience	Descriptive statistics were used to examine reasons for	56.4% of respondents reported "flavor" as the main reason for smoking cigarillos.

	sample	smoking cigarillos.	
Hookah			
Dani, 2015	Cross-sectional, convenience sample	Dichotomous variables (yes/no) were analyzed for significance	36.8% of hookah users indicated that hookah "contains pleasant flavors", compared to only 24.6% of non-users, p<.01
Salloum, 2015	Cross-sectional, purposive convenience sample	Multinomial logit models were used to estimate the impact on consumer choice of attributes.	Flavor accounted for almost two-thirds (65%) of the waterpipe smoking decision, compared to price (22%) and nicotine content (13%). Compared with males, females were more likely to prefer Blue Mist and Pirate's Cave flavors and less likely to prefer tobacco flavor (non-flavored). Participants were significantly more likely to choose Double Apple and Blue Mist flavors and significantly less likely to choose tobacco flavored (non-flavored) waterpipe products. The flavor attribute had the strongest influence on preferences, with fruit flavored waterpipe products on average preferred to tobacco flavored products; the effect was stronger among females and non-smokers of cigarettes.
Smith, 2011	Cross-sectional, convenience sample	Descriptive statistics examined why respondents thought hookah is safer or less addictive than cigarettes.	4.6% of respondents reported the reason why hookah is safer or less addictive than cigarettes is that "the tobacco/smoke is flavored."
Smokeless tobacco			
Adkison, 2014	Cross-sectional, convenience sample	Differences regarding perceptions of health risks associated with smokeless tobacco pack design characteristics were examined using X^2 tests. Multinomial regression was	More than half of respondents indicated there was no difference between packaging elements (e.g., flavor descriptor) on their product opinions regarding health risk and perceptions of appeal. Youth (ages 14-17), compared to older adults (ages 26-65), were more likely to report the pack with the flavor descriptor as having the best taste (OR: 1.7, CI: 1.9-2.4), that they want

		employed to evaluate the association between packaging elements and participant age.	to be seen using the product (OR: 2.1, CI: 1.4-3.2), that it appeals to people their age (OR: 2.1, CI: 1.5-3.0), and that it has reduced health risks (OR: 1.8, CI: 1.0-3.1) compared to reporting no difference between packs. Young adults (ages 18-25), compared to older adults (ages 26-65), were more likely to report the pack with the flavor descriptor as attracting their attention (ORI: 1.7, CI: 1.2-2.2), having the better taste (OR: 2.0, CI: 1.5-2.8), to want to be seen using (OR: 2.4, CI: 1.2-3.3), and appealing to people their age (OR: 2.3, CI: 1.7-3.2). Young adults also had increased odds of reporting the pack without the descriptor would deliver more dangerous chemicals than older adults (OR: 1.8, CI: 1.1-2.9).
Oliver, 2013	Combined data from 5 previously conducted studies	Descriptive statistics were used to examine product choices among smokeless tobacco users. Flavors were placed into 2 categories: No Flavor (Classic, None, Straight) or Mint Flavor (Ice, Mint, Spearmint, Wintergreen).	Approximately 60% of respondents used a mint-flavored product as their first product used or product that they first used regularly or daily. Smokeless tobacco users who started by using non-flavored products were more likely to switch to mint-flavored products compared with the other way around ($p<.0001$).
Bidi			
CDC, 1999	Cross-sectional, convenience sample	Descriptive statistics were used to examine why bidis were smoked instead of cigarettes among adolescents.	1.4% of respondents (4/280) cited “like the flavor” as the reason of why they smoked bidis instead of cigarettes. 23% of Responses (63/280) reported the reason of why they smoked bidis instead of cigarettes was that bidis tasted better than cigarettes.
Various tobacco products			
Ambrose, 2015	Cross-sectional, nationally representative sample	Descriptive statistics were used to examine proportion of flavored use among users, and reasons for tobacco product	Product flavoring was consistently reported as reason for use across all product types; e-cigarettes (81.5%), hookahs (78.0%), cigars (73.8%), smokeless tobacco (69.3%), and snus pouches (67.2%).

		use.	For past 30-day youth tobacco use, the overall proportion of flavored product use was 79.8% (95% CI, 77.3%-82.3%) among users of any product and 89.0% among hookah users, 85.3% among e-cigarette users, 71.7% among users of any cigar type, and 59.5% among cigarette smokers. The majority of ever-users reported that the first product they had used was flavored, including 88.7% of ever hookah users, 81.0% of ever e-cigarette users, 65.4% of ever users of any cigar type, and 50.1% of ever cigarette smokers. The overall proportion of flavored product use was 80.8% (95% CI, 79.1%-82.5%)
King, 2014	Cross-sectional, nationally representative sample	Descriptive statistics were used to determine differences in intention to quit by respondent characteristics.	Among current cigar smokers, the prevalence of those not thinking about quitting tobacco use was higher among current flavored little cigar users (59.7%) than non-flavored users (49.3%). Among current cigarette smokers, the prevalence of those who were thinking about quitting tobacco use within the next 30 days was lower among current flavored cigarette users (9.8%) compared to non-flavored users (18.4%).
Lee, 2015	Cross-sectional, nationally representative sample	Associations between multiple product use and all other characteristics were examined among current cigarette smokers by multinomial logistic regression. Adjusted relative risk ratios (aRRR) were calculated in reference to exclusive cigarette	Among current cigarette smokers, use of flavored products was significantly associated with dual use (aRRR=2.08, p<.01) and polytobacco use (aRRR=6.09, p<.001).

		use in a model that included all variables.	
Minaker, 2015	Cross-sectional, nationally generalizable sample	Logistic regression models were used to examine differences in smoking susceptibility by use of flavored and all ATPs and by sociodemographic and lifestyle characteristics.	Students who had ever tried a flavored ATP had significantly higher odds of being susceptible to cigarette smoking (OR=2.07, 95% CI 1.54 to 2.78) compared to students who never tried any types of tobacco. Students who tried flavored tobacco in the past 30 days had significantly higher odds of being susceptible to smoking relative to students who had never smoked a cigarette and had not consumed ATPs in the past 30 days (OR=1.86, 95% CI 1.25 to 2.77). Students who reported smoking flavored ATPs ever or in the past 30 days did not have significantly different cigarette smoking susceptibility compared to those who smoked flavored ATPS ever or in the past 30 days, respectively.

Romijnders et al. (2018) Supplementary Table

Supplementary Table S3. Main findings of included articles in alphabetical order.

	First Author	N	Country	Brief study description	Mayor relevant findings
[34]	Adkison, O'Connor, Bansal-Travers, Hyland, Borland, Yong, Cummings, McNeill, Thrasher, Hammond and Fong [34]	U.S. (n = 1520), UK (n = 1325), Canada (n = 1581), Australia (n = 1513): total n = 5939	U.S., UK, Canada, Australia	International Tobacco Control (four-country) survey). Cross-sectional data from the U.S. (n = 1520), UK (n = 1325), Canada (n = 1581), Australia (n = 1513) total n = 5939. Types of user as defined by authors: 'Current smoker; smoked at least 100 cigarettes in their lifetime and at least 1 cigarette in the past 30 days. 18 years or older current (at least 100 cigarettes lifetime and 1 cigarette past 30 days) and former smokers.'	PERCEPTIONS less harmful than traditional cigarettes: all: 70.3%; Canada: 63.9%; U.S.: 65.9%; UK: 82.2%; Australia: 71.0%. Perception of harm was higher in the US than UK (i.e. e-cigs are legal), and higher in Canada than Australia (i.e. e-cigs are banned). 79.8% using e-cigs because considered less harmful than traditional cigarettes; 75.4% used e-cigs to help reduce smoking; 85.1% using e-cigs to help quit smoking. Those who reported that e-cigs were less harmful than traditional cigarettes had nearly four times greater odds of trying e-cigs. (e-cigs users were more likely to have reduced their cigarettes per day between waves than non-users).
[35]	Amato, Boyle and Levy [35]	n = 9304	U.S.	The 2014 Minnesota Adult Tobacco Survey; a cross-sectional sample of Minnesotan adults aged 18 years or older. Types of user as defined by authors: 'Past users 0 days in past. Infrequent users 1–5 days in past. Intermediate users 6–29 days in past. Daily users; Every day in past.'	REASONS Goal oriented: To quit other tobacco products, to cut down, less harmful, to use them in places where other tobacco is not allowed, affordable. Non-goal oriented: curiosity, menthol flavor, other flavors.
[36]	Ambrose, Rostron, Johnson, Portnoy, Apelberg, Kaufman and Choiniere [36]	n = 24,658	U.S.	National Youth Tobacco Survey (n = 24,658); cross-sectional. Types of user as defined by authors: 'Current smokers: individuals who reported smoking on. At least one of the past 30 days. Ever smokers: those who reported ever having tried cigarette smoking but not smoking within the past month. Dual use: any reported past 30 days use of e-cigarettes among current cigarette smokers. 11–18 years old; non-users, smokers and e-cigarette users current, (1 in past 30 days) ever and never cigarette smokers.'	PERCEPTIONS 30.6% overall believed e-cigarettes to be less harmful than regular cigarettes, 25.0% of never smokers, 41.3% of ever smokers, and 54.2% of current smokers 64.2% perceived harmfulness cigarettes dose-dependent.
[37]	Anand, McGinty, O'Brien, Guenthner, Hahn and Martin [37]	n = 2769	U.S.	Cross-sectional data from the U.S. (n = 2769) among youth. Types of user as defined by authors: 'Current use: past 30 day use. Ever use: lifetime use.' 14–18 years old; e-cigarette users, smokers and other tobacco product users	PERCEPTIONS 60% minor health hazard. Healthier (7.5%), safer (6.9%), can be used anywhere (5.4%), do not have harmful chemicals (3.4%), mimic tobacco smoking (6.0%), trendier (3.5%), easier to get (2.0%), and more affordable (1.2%) safer (6.9%), no harmful chemicals (3.4%). REASONS helped to smoking cessation (31.0%) 51% of e-cigarette users and 28% of none-cigarette users, accessibility (2.0%): (most accessible from friends (35.9%)), health benefits (7.5%), avoid smoking restriction (5.4%), mimic smoking (6.0%), trends (3.5. %), costs (1.2%). E-cigarettes most accessible from friends (35.9%) tobacco stores (23.5%), gas stations (17.2%), and family (13.2%).

[38]	[38]	n = 12	Malaysia	Qualitative research (interviews) with 21–40 year old e-cigarette users. Types of user as defined by authors: 'Past and current users (have been using for <1 year, > 1 year, more than 2 year), of e-cigarettes). Past users are not specified.'	REASONS Smoking cessation, cut back on smoking, alternative way of tobacco consumption, costs, health benefit, withdrawal symptoms, satisfaction
[39]	Bauhoff, Montero and Scharf [39]	n = 796	U.S.	Cross-sectional survey using an online platform (n = 796). Types of user as defined by authors: 'Participants were never smokers (56%) or ever smokers (44%). 72% never tried e-cigarettes. 18 to 64 years old. Those who were aware of e-cigarettes were asked if they had "ever used" e-cigarettes and how often they used e-cigarettes in the last 30 days.'	PERCEPTIONS believe that e-cigarettes can help smokers quit smoking (58%), less harmful than smoking (64%). not less addictive than smoking (27%). current smokers more likely that e-cigarettes could help smokers quit (64%). ever smokers more likely than never smokers to believe that e-cigarettes are cheaper than regular cigarettes. REASONS top reasons: to reduce or quit smoking (58%), curiosity (19%), less smelly than cigarettes (19%). Perceived healthier (13%) can replace smoking cessation products (13%).
[40]	Baweja, Curci, Yingst, Veldheer, Hrabovsky, Wilson, Nichols, Eissenberg and Foulds [40]	n = 200	U.S.	Mixed methods, self-report with open-ended questions (n = 200). Types of user as defined by authors: 'Current adult e-cig users (current user is not specified).' All adult (18 years or older) e-cigarette users, median age 40.5 years.	PERCEPTIONS perceived as less harmful than smoking (36.5%). Safe way to use nicotine REASONS health benefit (36.5%), smoking cessation (25%), vape quality (94%), battery life (82%) and liquids (59%). Starting e-cig use to quit tobacco soon (73.5%), e-cigs help quit smoking (93.5%). Pleasurable, improve sense of smell and taste, costs, routine maintenance, no odors, social environment. Device characteristics (design; ability to control voltage, simple to operate and maintain, durability, consistent performance of e-cig device and experience, taste and variety of flavors; throat hit, compatibilities of variety of e-cig components, machine quality, cost of e-cigarette device, battery life, tank size, safety features, easy availability of e-cigs, and the ability to customize liquids and coils), smoking cessation and reduced cigarette consumption; unexpected health effects; improved breathing; decreased cough, fewer sore throats; pleasure & smoking-related actions; less toxic than smoking tobacco; sense of smell and taste; less expensive than cigarettes; feasibility to use e-cigs; similar gestures or action of smoking cigarette; no unpleasant odors; taste and variety of flavors; safe for others or bystander with no second hand smoke; cravings; dental health.
[41]	Berg [41]	n = 1567	U.S.	Cross-sectional (n = 1567) Types of user as defined by authors: 'Current smoker; smoked in the past 30 days. Former smoker; smoked more than 100 cigarettes in their lifetime but did not smoke in the past 30 days.' 18-34 years old; REASONS for use among current e-cigarette users	PERCEPTIONS electronic cigarettes were perceived as one of the least harmful (41%), addictive and most socially acceptable. REASONS less harmful than cigarettes (77%), do not smell (77%), smoking cessation (66%), costs (62%), weight management (6.6%) avoid smoking restrictions (25.2%), socially acceptable (48.7%), flavors (60.2%).

[42]	Biener and Hargraves [42]	n = 695	U.S.	Mixed methods, self-report (n = 1374) and interviews (n = 695) Types of user as defined by authors: 'Level 3 = intensive users: used daily for at least 1 month. Level 2 = intermittent users: used more than once or twice but not daily for a month or more. Lever 1 = non-users or at most once or twice.' Adult smokers (18 - 65 years old); motivation among e-cigarette users	REASONS to smoking cessation 52.6%, avoid smoking restriction 5.6%, social environment (16.1%), Cut back 4.5%, health benefit 8%. PERCEPTIONS e-cig healthier than regular cigarettes (16.1%).
[43]	Biener, Song, Sutfin, Spangler and Wolfson [43]	n = 4,740	U.S.	Self-report (n = 4740) Types of user as defined by authors: 'Current smokers: those who had at least smoked 100 cigarettes and either smoked every day or some days. Former smokers: those who had at least smoked 100 cigarettes but now smoked not at all. Never smokers: those who denied having smoked 100 cigarettes in their lifetime or never used any tobacco products.' 18–35 years old; motivation asked among smokers	REASONS Curious 61.2% Current smokers; 59.1% former smokers; 77.3% Never smokers; Better for health than cigs 55.1% Current smokers; 42.7% Former smokers; 17.2% Never smokers; Friends use it 30.9% Current smokers; 28.1% Former smokers; 46.0% Never smokers; Can use in no-smoking areas 43.1% Current smokers; 33.8% Former smokers; Help to quit smoking 35.9% Current smokers; 40.1% Former smokers ; Cut down on smoking 41.1% Current smokers; 18.5% Former smokers; Doesn't smell bad 42.7% Current smokers; 37.8% Former smokers; 25.9% Never smokers.
[44]	Bold, Kong, Cavallo, Camenga and Krishnan-Sarin [44]	n = 340	U.S.	Longitudinal survey ever users, age 14–17. Types of user as defined by authors: 'Students were selected as ever e-cigarette users if they responded "yes" to the question "have you ever tried an e-cigarette". '	REASONS Interest: Curiosity, It is cool. Desirable attributes: Good flavors, Does not smell bad, and Hide from adults, Low cost. Social norms: Friends use, Parents/family use, Can use anywhere. Goal-directed: To quit smoking cigarettes, Healthier than cigarettes.
[45]	Brose, Brown, Hitchman and McNeill [45]	2012 n = 4553, 2013 n = 1588, 2014 n = 1204	UK	UK cohort study (n = 4553 in 2012, n = 1588 in 2013 & n = 1204 in 2014). Types of user as defined by authors: 'Current use: used e-cigarette daily, less than daily but at least once a week, less than weekly but at least once a month and less than monthly. Current smoker: Smoke cigarettes every day, not every day, or smoke tobacco of some kind. Ex-smoker: stopped smoking in the past year or more than a year ago.' smokers and former smokers 18 years or older	PERCEPTIONS e-cigarettes perceived as less harmful than combustible cigarettes, but changed overtime (66.6%: 2012; 66.5%: 2013; 60.4%: 2014)
[46]	Brown, West, Beard, Michie, Shahab and McNeill [46]	n = 4117	UK	Cross-sectional (n = 4117) Types of user as defined by authors: 'Current smokers: smoke every day, not every day or smoke tobacco of some kind but not cigarettes. Recent ex-smokers: stopped smoking completely in the last year.' 18 years or older Current smokers and recent ex-smokers	PERCEPTIONS perceived as less harmful Current smokers 67.6% believe less harmful; ex-smokers 63.2% less harmful REASONS health benefit, cutting down & quitting (current uses), taste (ex-smokers) Among Current users of e-cigarettes: health benefit:82.6% current smokers, 83.5% recent ex-smokers; taste:24.4% current smokers, 39.4% recent ex-smokers; cutting

					down:83.0% current smokers, 78.9% recent ex-smokers; temporary abstinence:70.2% current smokers; 47.7% recent ex-smokers; quitting:82.8% current smokers, 84.4% recent ex-smokers
[47]	Chaffee, Gansky, Halpern-Felsher, Couch, Essex and Walsh [47]	n = 104	U.S.	Cross-sectional (n = 104) Types of user as defined by authors: 'Current use: participants who had use e-cigarettes on one or more days in the past 30 days Ever use: participants who had hear of electronic cigarettes and ever used e-cigarettes, even once or twice.' All male 13–18 years old; e-cigarette users and non-users	PERCEPTIONS believed to be likely (40%–75%): decreased athletic performance, trouble breathing, coughing, lung cancer, heart attack mouth cancer, mouth sores. Believed to be likely (40%–80%): upset your family, get into trouble, upset friends, bad breath, addictive, dental issues, harmful for others. Believed to be beneficial (15%–60%): relaxed, cool, fit in more, feel alert, and increased performance. Decreased athletic performance 57.3% never users, 28.0% ever users; Trouble catching your breath 54.7% never users, 19.2% ever users; Bad cough 53.2% never users, 23.9% ever users; Lung cancer 52.2% never users, 21.8% ever users; Heart attack 48.7% never users, 16.8% ever users; Mouth cancer 46.4% never users, 15.0% ever users; Mouth sores 45.5% never users, 20.8% ever users; Upset your family 68.2% never users, 38.2% ever users; Get into trouble 56.8% never users, 54.0% ever users; Upset your friends 50.2% never users, 18.4 % ever users; Bad breath 49.9% never users, 23.8% ever users; Become addicted 49.7% never users, 37.6% ever users; Brown teeth 41.5% never users, 17.2% ever users; Harm someone nearby 38.7 never users, 19.7% ever users. REASONS Feel more relaxed 44.6% never users, 50.2% ever users; Look cool 39.2 % never users, 45.8 % ever users; Fit in more 33.2% never users, 36.4% ever users; Feel more alert 27.7% never users, 26.4% ever users; Increased athletic performance 18.0% never users, 19.2% ever users;
[48]	Cheney, Gowin and Wann [48]	n = 30	U.S.	Qualitative interviews (n = 30) in the U.S. Aged 19–24 years old. Types of user as defined by authors: 'E-cigarette and dual users. (2) current use (within the past week) of e-cigarettes.'	REASONS young adults: to continue e-cigarette use was that it kept them from smoking, to help them cope with stress, rewarding feelings of hand-to-mouth motions, form of entertainment, immediate health benefits, not smelling like smoke. Flavors filled a positive role as they were often a way to connect with other e-cigarette users, and a reason for continuing to use e-cigarettes, always many more to try, flavor made e-cig use more attractive than smoking. Dual use: help to cope with stress when exclusive use is not enough, bond with other smokers, convenience in a particular situation, influence young adult smokers with positive comments about e-cigs, family members introduced young adults to e-cigarettes, family member influence decision to start e-cigarette use, friends played a supportive role in initiation of e-cig use and continuation. It is perceived as socially acceptable behavior.
[49]	Coleman, Johnson, Tessman, Tworek, Alexander, Dickinson, Rath and Green [49]	n = 116	U.S.	Qualitative research (focus groups n = 116). Types of user as defined by authors: 'Current use: use of an e-cigarette product in the past 30 days.' 18–30 years old; current e-cig users	PERCEPTIONS persisted that e-cigarettes are less harmful. E-cigarettes a method to reduce or quit smoking, where smoking is not permitted, the perception of e-cigarettes as more socially acceptable, and the availability of a variety of flavors. Lack of knowledge about e-cigarettes ingredients

					affect in general and on health. Most tried e-cigarettes for the first time with friends, and overall, friends are positive. REASONS ability to use as a smoking cessation method, avoid smoking restriction, socially acceptable, health benefit. However, not mimic smoking.
[50]	Dockrell, Morrison, Bauld and McNeill [50]	Structured interview, n = 1380 & self-report, n = 25,029 (2010 n = 12,587; 2012 n = 12,432)	UK	Mixed methods (structured interview, n = 1380 & self-report, n = 25,029) Types of user as defined by authors: 'smoking status: never-smoking, ex-smoking, occasional, and daily smoking. 18 years or older; both smokers (smokers' survey) and general population (population survey).'	PERCEPTIONS believed to aid smoking cessation efforts: 60% satisfy the desire to smoke, 55% Cut back on e-cigarettes, 53% believed it expensive, 51% help quit entirely, 39% believed it might not satisfy the desire to smoke, 71% perceived e-cigarettes as less harmful than combustible cigarettes. 28% considered them less harmful than Nicotine Replacement Therapy (NRT). REASONS avoid smoking restrictions (43%), 35% to smoking cessation, 31% cut back on smoking.
[51]	Dutra and Glantz [51]	2011 n = 17,353, 2012 n = 22,529	U.S.	National Youth Tobacco Survey (n = 17,353 in 2011 & n = 22,529 in 2012): Types of user as defined by authors: 'Experimenters; Have you ever tried cigarette smoking, even one or two puffs? 'Yes'. Ever smoker; 100 or more cigarettes (5 or more packs) of lifetime smoking. Current smoker; had smoked at least 100 cigarettes and smoked in the past 30 days. Ever e-cigarette users: adolescents who responded 'electronic cigarettes or e-cigarettes, such as Rayan or NJOY' to the question 'which of the following tobacco products have you ever tried, even just 1 time?' Current e-cigarette users: those who responded 'e-cigarettes' to the question 'during the past 30 days, which of the following tobacco products did you use on at least 1 day?' Dual ever use: who have ever used e-cigarettes and ever smoked conventional cigarettes. Dual current use: who are currently using e-cigarettes and conventional cigarettes? 11–18 years old; Ever and current e-cigarette users.'	REASONS Among current smokers, motives for ever e-cigarette use was related to quitting combustible tobacco use. smoking cessation

[52]	Eastwood, Dockrell, Arnott, Britton, Cheeseman, Jarvis and McNeill [52]	2013 n = 2062, 2014 n = 1952	UK	11–18 years old. Types of user as defined by authors: population not stratified. never smokers, former smokers, current smokers	PERCEPTIONS some perceived e-cigarettes to be less harmful to the user decreased significantly, from 73.4% in 2013 to 66.9% in 2014. Considered e-cigarettes to cause about the same level of harm to the user increased from 11.8% in 2013 to 18.2% in 2014. Believing them to be less harmful decreased from 78.5% in 2013 to 73.1% to in 2014, and similar levels of harm increased from 8.0% to 12.0%.

[53]	Etter [53]	n = 81	France, Canada, Belgium & Switzerland	Self-report (n = 81) Types of user as defined by authors: 'daily user, non-daily user, former user, never used. Smoking status: daily, non-daily, former smoker, never smoker.' 19–65 years old; Ever e-cigarette users	REASONS To quit smoking, for health benefits (e-cigarettes were perceived to be less toxic than tobacco), less expensive than regular cigarettes, can be smoked everywhere (including smoke-free places), to avoid disturbing other people, or producing environmental tobacco smoke or the smell of stale smoke, for the pleasure of smoking (including the pleasure of inhaling and smoking related actions), to reduce cigarette consumption, curious to test a new product, e-cigarettes taste and smell good, previously failed quit attempts, to get nicotine, unexpected health effects.
[54]	Etter and Bullen [54]	n = 3587	62% U.S. 14% France, 6% UK, 4% Switzerland, 3% Canada, 11% other countries	Self-report (n = 3587) Types of user as defined by authors: 'Daily users, occasional users (not daily), past users (used e-cigarettes in the past), and never users (never used e-cigarettes). 18 years or older e-cigarette users, smokers and non-smokers.'	PERCEPTIONS less harmful than tobacco 83.5% REASONS smoking cessation (76.8%), deal with cravings (79%), withdrawal symptoms (67%), costs (57.3%), avoid smoking restrictions (34%) (avoid going outside is 34.4%, avoid situations where you cannot smoke is 39.4%, social environment (to avoid bothering other people with tobacco smoke (44%)), avoid smoking restrictions (39%), cut down tobacco 28%), unable to stop using it (4%). Current smokers: helped them to reduce their smoking (92%). Former smokers: (96%) said that it helped them to quit smoking. Ever users: (89%) said that it was easy to abstain from smoking while using the e-cigarette
[55]	Faletau, Glover, Nosa and Pienaar [55]	n = 20	New-Zealand, Auckland	Qualitative Research (Focus groups n = 20) Types of user as defined by authors: Children aged 6–10 years; non-users	PERCEPTIONS children thought it looked cool, viewed is as an imitation cigarette, viewed as smoking.
[56]	Ford, MacKintosh, Bauld, Moodie and Hastings [56]	n = 20	New-Zealand, Auckland	Youth Tobacco Policy Survey (n = 1205); cross-sectional Types of user as defined by authors: 'Regular smokers: at least one cigarette a week. Occasional smoker's less than one cigarette a week. Never smokers: those who had never tried smoking, not even a puff or two. Ever smokers: regular smokers, occasional smokers, those who used to smoke and those who had tried smoking only once. 11–16 years old; ever (at least one cigarette a week), occasional smokers (less than one a week), those who used to smoke and those who had tried smoking only once, and never smokers.'	PERCEPTIONS perceived harm differed for flavors, with candy and fruit flavors considered less harmful than tobacco flavors. Perception of flavor matching goal of using e-cigarettes (e.g., adult smoker giving up smoking would favor tobacco flavors).
[57]	Gowin, Cheney and Wann [57]	n = 30	U.S.	Qualitative research (semi-structured individual interviews n = 30) with current e-cigarette users. Types of user as defined by authors: 'Current use of e-cigarettes (at least once per week). Young adults (19–31) who go straight to work (STW) from high school.'	PERCEPTIONS e-cigarettes are healthier and a safer, e-cigarettes are cheaper, e-cigs are healthier and safer from themselves, it is a safer option than smoking, it is healthier and safer for others, no second hand smoke, nice smell, less harmful, environmental friendlier and reduces less waste. REASONS healthier, safer, cheaper, safer for self and other, environmental friendlier than smoking

[58]	Hess, Antin, Annechino and Hunt [58]	n = 46	U.S.	Qualitative research (focus groups n = 46). Age 18–25 years old. Types of user as defined by authors: No type of user or frequency specified.	PERCEPTIONS utilitarian function and a social function. Social identity of e-cigarettes is described as different form the participants, described with an "us versus" them attitude. Utilitarian function neither as smoking reduction or cessation nor to minimize craving when smoking is prohibited.
[59]	Hilton, Weishaar, Sweeting, Trevisan and Katikireddi [59]	n = 86	UK	Qualitative research (focus groups n = 86). Age 14–17 years old. Types of user as defined by authors: 'Smoking status: do you smoke cigarettes at all nowadays? And which statement describes you best: never tried, not even a puff or two; once had a puff or two, but never smoke now; do you sometimes smoke? E-cigarette use: do you use e-cigarettes at all nowadays? And which statement describes you best: never tried, not even a puff or two; once had a puff or two, but never use e-cigarettes now; do you sometimes use e-cigarettes?'	PERCEPTIONS potential health harms and unknown harmful ingredients. Unsure whether e-cigarettes are more or less addictive than conventional cigarettes. REASONS great flavor, colors, fun tricks, fitting in, looking cool.
[60]	Huerta, Walker, Mullen, Johnson and Ford [60]	n = 3630 in 2012 n = 3185 in 2013 n = 3677 in 2014 Pooled n = 10,273	U.S.	Health Information National Trends Survey (HINTS) 2012–2014. Types of user as defined by authors: 'Smoking status was defined in the same manner for this study and the original study, defining non-smokers as those who have smoked <100 cigarettes during their lifetime, current smokers as those who have smoked >100 cigarettes and are still smoking every day or most days, and former smokers as those who have smoked >100 cigarettes in their lifetime and are not smoking now. U.S. adults (18>) smokers, former smokers and non-users.'	PERCEPTIONS Perceived harm declined slightly from 2012 to 2014 (50.7% to 43.1%). Current and former smokers had higher odds of perceiving e-cigarettes as less harmful.
[61]	Kahr, Padgett, Shope, Griffin, Xie, Gonzalez, Levison, Mastrobattista, Abramovici, Northrup, Stotts, Aagaard and Suter [61]	n = 87	U.S.	Qualitative research (focus group n = 87); Types of user as defined by authors: 'pregnant women's beliefs of e-cigarette users during pregnancy; use not specified.' adult pregnant women; non-users.	PERCEPTIONS compared to combustible cigarettes, e-cigarettes were perceived as less harmful. However, e-cigarettes were not perceived safe during a pregnancy, damaging to baby, not safe during pregnancy, may be a smoking cessation tool, better alternative than regular cigarettes. Smoking causes health problems during pregnancy, smoking is selfish and irresponsible. Smoking is perceived as not acceptable during pregnancy; not as strong for e-cigarettes. Still risks and not taking care of her baby's health if used.
[62]	Khoury, Manlhiot, Fan, Gibson, Stearne, Chahal, Dobbin and McCrindle [62]	n = 3312	Canada	Self-report (cross-sectional survey n = 3312) with n = 238 adolescents who tried e-cigarettes at least once. (Age 14–15 years old). Types of user as defined by authors: 'E-cigarette use status: "Have you ever taken at least one puff from an electronic cigarette?" and "If yes, why did	REASONS (among 238 adolescents ever users) cool/fun/new, for the buzz, helps to quit smoking, helps to smoke less, helps when not allowed to smoke.

				you try an e-cigarette?" (options: "a. It's cool/fun/something new; b. For the buzz; c. To help me quit smoking; d. To help me smoke less; e. To help me when I'm not allowed to smoke"). Smoking status: "Do you smoke now?" and "Think about the last 30 days. Did you smoke a cigarette, even a puff?'	
[63]	Kim, Davis, Dohack and Clark [63]	n = 35	U.S.	Qualitative research (focus groups, n = 35). Types of user as defined by authors: 'with adult e-cigarette users (18–65 years old) using e-cigarettes for at least two month prior to the study. (1) those who were current users of both e-cigarettes and combustible cigarettes; (2) those who were former combustible cigarette users;	PERCEPTIONS perceived as healthier, safer, and cleaner alternative compared to smoking. Respondents feel better; have more energy; breathe easier; cough less since using e-cigarettes.
[64]	Kinnunen, Ollila, Lindfors and Rimpela [64]	n = 10,233	Finland	The 2013 and 2015 Adolescent Health and Lifestyle Survey, which is a cross-sectional postal survey. Types of user as defined by authors: 'Self-report (survey n = 10,233) among Finnish adolescents (12-, 14-, 16- and 18-year-olds obtained from the population register center). Tried e-cigarettes at least once. E-cigarette use: "Have you ever tried electronic cigarettes? How many times altogether?" The options were: "I do not know what they are", "No", "I have tried once or twice", "I have tried 20 times or less" and "I have tried more than 20 times". Frequency was estimated in 2015: "Which one of the following alternatives best describes your current use of e-cigarettes?" with the options "I do not use e-cigarettes", "I use e-cigarettes less than once a week", "I use e-cigarettes once a week or more often, but not daily" and "I use e-cigarettes once a day or more often".'	REASONS to try something new, to quit smoking, friends use them, something new to try.
[65]	Kistler, Crutchfield, Sutfin, Ranney, Berman, Zarkin and Goldstein [65]	n = 34	U.S.	Qualitative research (n = 34). Age 18–64 years old. Types of user as defined by authors: 'Used e-cigarettes at least once.'	REASONS reasons included: User Experience (The odor, feel, texture, appearance, taste, cloud chasing, and novelty); Social Acceptability (encouragement or acceptability to use e-cigs and to connect with others who vape vice versa when there is stigmatization or no acceptability to use e-cigs); Cost; Health Risks/Benefits (health issues or benefits); Ease of Use (The difficulty or ease to manipulate or use an e-cig, availability of products, and setting in which it can be sued); Flavor (type of flavors, the mixing of flavors, the smell of flavors); Smoking Cessation Aid;

					Nicotine Content & the ability to control it; Modifiability; e-cigs Regulation; Dual use; Hobby use.
[66]	Lee, Lee and Cho [66]	n = 6655	Korea	2015 Korean Youth Risk Behavior Web-based Survey (n = 6655) age 13–18 years old ever e-cigarette users. Types of user as defined by authors: 'Ever conventional cigarette smokers "yes" to the question: "Have you ever tried a cigarette, even one puff, in your life?" Among ever-smokers, current conventional smokers: those who replied from "1 and 2 days" to "every day" for the question, "During the past 30 days, how many days did you smoke cigarettes, even one cigarette?" Ever e-cigarette use: "yes" answer to the following question: "Have you ever tried e-cigarettes?" Current e-cigarette use: those who replied from "1 and 2 days" to "every day" to the question, "During the past 30 days, how many days did you use e- cigarettes?" The number of days that used e-cigarette was re-grouped into 0–2 days/month, 3–9 days/month, and 10 days/month.'	REASONS Among ever e-cigarette users: curiosity (22.9%), belief that they were less harmful than conventional cigarettes (18.9%), to quit smoking (13.1%), to smoke indoors (10.7%). For infrequent e-cigarette users (<3 per month), curiosity was the most frequent reason for e-cigarette use (28.8%). For more frequent e-cigarette users (>10 per month), to quit smoking (21.0%) and indoor use (19.5%) were the most frequent reasons for e-cigarette use. The belief that e-cigarettes are less harmful was a common reason for use among both less (<3 per month) and more (>10 per month) frequent users of e-cigarettes (19.3% and 17.9%, respectively).
[67]	LeVault, Mueller-Luckey, Waters, Fogleman, Crumly and Jenkins [67]	n = 309	U.S.	Based on the Minnesota Adult Tobacco Survey (2010) and the Brief Smoking consequences Questionnaire–Adult. Types of user as defined by authors: 'n = 309; there were 235 current cigarette smokers consisting of 79 who smoked only cigarettes (smokers); 122 who used both cigarettes and e-cigarettes (dual users); and 34 former e-cigarette users. Only smokers and dual users were included in this analysis. 18 years or older.'	REASONS reasons for dual use were to reduce or to quit smoking (79.5%).
[68]	Li, Bullen, Newcombe, Walker and Walton [68]	n = 840	New-Zealand	The New Zealand Smoking Monitor (n = 840) Types of user as defined by authors: 'Sample of current smokers: who smoked at least one cigarette a month and who had not made a quit attempt lasting 24 hours or more in the past three months, and those who have made a quit attempt lasting 24 hours or longer in the past three months which may or may not have been sustained. Use of e-cigarettes not specified.' Current smokers and recent quitters 18 years or older	PERCEPTIONS One-third agreed that e-cigarettes were safer than tobacco cigarettes (n = 158) and agreed e-cigarettes could help people quit smoking (n = 162)
[69]	Li, Newcombe and Walton [69]	n = 2594	New-Zealand	The New Zealand Smoking Monitor (n = 2594) Types of user as defined by authors: 'Ever use: Have you ever tried an electronic cigarette?	REASONS 57.1% curiosity, 31.3% wanted to quit,8.4% alternative for tobacco cigarettes, 2.8% due to a recommendation, 2.5% safer, 2.4% avoid smoking restrictions, 1.2% costs (among ever users). 15.4% curiosity,

				Current use: which best describes how often you use an electronic cigarette now? At least once a day/at least once a week/at least once a month. Current smoker's non-attempter: smoked at least one cigarette a month and who had not made a quit attempt lasting 24 hours or more in the past three months. Recent quit attempters: those who have made a quit attempt lasting 24 hours or longer in the past three months which may or may not have been sustained.' Current smokers and recent quitters 18 years or older.	50.9% wanted to quit, 21.7% alternative for tobacco cigarettes, 0.8% due to a recommendation, 4.9% safer, 10.3% avoid smoking restrictions, 6.1% costs (among current users).
[70]	Lotrean [70]	n = 480	ROMANIA	Cross-sectional data from Romania (n = 480) among students Types of user as defined by authors: 'Smokers: individuals who had smoked in the past month. Ex-smokers: those who had smoked in their lifetime but not in the past month. Non-smoker: those who had not smoked traditional cigarettes. Ever e-cigarette use: had tried at least once in lifetime. Students aged 19–24. 53.3% of the smokers, 25% of the ex-smokers and 5.5% of the non-smokers had tried e-cigarettes. Definition of use is not provided.'	PERCEPTIONS E-cigarettes are less dangerous; overall 55.9%. Ever users; 62.3% smokers; 33.3% former smokers; 58.7% non-smokers; E-cigarettes can help smokers to quit; overall 66.4%. Ever users; 46.1% smokers; 70.8% former smokers; 79.4% non-smokers; E-cigarettes are used only by smokers; 48.9% overall.; 51.3% smokers; 50.0% former smokers; 46.8% non-smokers. REASONS E-cigarettes are less dangerous 8% overall; 0% smokers; 50% former smokers; 0% non-smokers; To quit smoking 23.2% overall; 31.7% smokers; Curiosity 62.5% ever users; 65.9% smokers; 50.0% former smokers; 58.3% non-smokers; Other friends also tried e-cigarettes 23.2% overall; 25.6% smokers; 0% former smokers; 41.7% non-smokers.
[71]	Majeed, Stanton, Dube, Sterling, Burns and Eriksen [71]	n = 14	U.S.	Qualitative research (focus groups (n= 14)). Types of user as defined by authors: 'Current cigarette users (adults: 18 years or older) who ever used e-cigarettes. (self-identified as current smokers; had used e-cigarettes, even once).'	REASONS for experimentation: curiosity, cravings, coolness, convenience, persuasive persons. Reasons for regular use: cravings, sensory experience, coolness, perceived reduced harm, convenience.
[72]	Majeed, Weaver, Gregory, Whitney, Slovic, Pechacek and Eriksen [72]	A total of 4170; 5717; and 6,051 respondents completed the 2012, 2014, and 2015	U.S.	Tobacco Products and Risk PERCEPTIONS Surveys, cross-sectional, with U.S. adults (18>). Types of user as defined by authors: 'Non-users, smokers, and former smokers. Current smokers were defined as adults who had smoked at least 100 cigarettes during their lifetime and reported currently smoking every day or some days. Former smokers were defined as adults who had smoked at least 100 cigarettes and responded not at all to the question about current smoking. Those who had not smoked at least 100 cigarettes in their lifetime were defined as never smokers.'	PERCEPTIONS There is an increase perception that e-cigarettes are "about the same level of harm" as or to be "more harmful" than cigarettes. Uncertain about harm: decreased (47.8%) in 2012 to 29.5% in 2015.
[73]	Mark, Farquhar, Chisolm, Coleman-Cowger and Terplan [73]	n = 316	U.S., University of Maryland	Self-report (n = 316) among pregnant women	PERCEPTIONS less harmful for baby 43%, less harmful to self (45%), cheaper (31%), fashionable (18%), contain nicotine (57%), addictive (61%), contains tobacco (31%), not as bad for health (74%), taste better

			Women's Health Center	Types of user as defined by authors: 'Current use: past 30 days. Current smokers: smoked within the past 30 days. Pregnant women (66.1 % reported having ever heard of e-cigarettes, 13% reported having any prior or current use of e-cigarettes (ever users), with 0.6% reporting current daily use); 18 years or older.'	(54%), cut down (72%), avoid smoking restrictions (55%), smoking cessation tool (73%).
[74]	McKeganey and Dickson [74]	n = 650	UK	Self-report (survey n = 650) among smokers. 18 years or older. Types of user as defined by authors: '336 participants reported having tried/used e-cigarettes.' No clear definitions provided.	REASONS to avoid smoking bans, flavors available, cheaper than cigarettes, less harmful than cigarettes, attractiveness of the device settings and specifications. Among smokers: switching to e-cig use was more enjoyable than smoking. If this expectation was nog met, it led to continued smoking. Also, it was important how the technology worked, how it looked when using e-cigs, how people reacted to them vaping, whether it was a poor substitute for smoking, if they felt embarrassed.
[75]	McQueen, Tower and Sumner [75]	n = 15	U.S.	Qualitative research (interviews n = 15) Types of user as defined by authors: 'past year users, e-cigarette users who started using in the past year. 20–60 years old; e-cigarette users'	REASONS alternative way of tobacco consumption, smoking cessation, costs, maintain weight, sense of taste, smell, ability to be physically active, health benefit (unexpected and experienced), Cut back on nicotine fix, not smelling of cigarette smoke, immediate effects outweigh potential long-term harm
[76]	Patel, Davis, Cox, Bradfield, King, Shafer, Caraballo and Bunnell [76]	n = 13,304	U.S.	Internet surveys of U.S. adult conventional cigarette smokers and nonsmokers. n = 10,181 current cigarette smokers; n = 3123 nonsmokers aged 18 or older. Types of user as defined by authors: 'Current cigarette smokers = persons who had smoked at least 100 conventional cigarettes in their lifetime and currently smoked either "some days" or "every day" at the time of the survey. Non-smokers were defined as persons who reported smoking "not at all" at the time of the survey, regardless of lifetime number of conventional cigarettes smoked. Current e-cigarette users were defined as those who responded "every day" or "some days" to the question, "Do you now use e-cigarettes every day, some days, or not all?"'	REASONS among current users: cessation/health (84.5%) (less harmful, reduce number of cigarettes, other friends use them too); consideration of others (less harmful, don't smell); convenience (to avoid smoking bans), curiosity, flavors, costs, simulation of cigarettes. Non-smokers: curiosity, tank users mentioned costs, cessation, and simulation of cigarette sensation.
[77]	Pearson, Richardson, Niaura, Vallone and Abrams [77]	n = 2649 (online study) & n = 3658 (cohort)	U.S.	Legacy Longitudinal Smoker Cohort (LLSC) (n = 3658) and national cohort (n = 2649) Types of user as defined by authors: 'in both surveys: Never smokers: having never smoked up to 100 cigarettes in their lives. Former smokers: having smoked 100 cigarettes or more in their lives	PERCEPTIONS 70.6% of those aware in the online survey and 84.7% in the LLSC believed e-cigs are less harmful than combustible cigarettes.

				but currently smoking not at all. Current smokers: having smoked in excess of 100 cigarettes in their lives and currently smoking every day or smoke days. 18–49 years old recent quitters and current smokers (n = 3658) and 18 years or older never, former, and current smokers (n = 2649).'	
[78]	Pepper, Emery, Ribisl, Rini and Brewer [78]	n =6607	U.S.	Tobacco Control in a Rapidly Changing Media Environment (TCME) (n = 6607 current smokers) Types of user as defined by authors: 'Current use of e-cigarette: using them every day or some days. Ever use: tried e-cigarettes, even just one puff. Adult smokers; 18 years or older (mean age 44.2 years old)'	PERCEPTIONS participants perceived e-cigarettes less likely to cause lung cancer, heart disease, and oral cancer compared to regular cigarettes.
[25]	Pepper, Ribisl and Brewer [25]	n = 1125	U.S.	Self-report (survey n = 1125) age 13–17 years old Types of user as defined by authors: 'never smokers/e-cigarette users (89%), 4% current smokers and 5% current e-cigarette users. 3 categories of e-cigarette users: never users, ever users (used ≥1 time but not in the past 30 days), and current users (used ≥1 time in the past 30 days).'	PERCEPTIONS Perceived fruit-flavored to be less harmful, and were more likely to try menthol, candy or fruit flavored e-cigarettes.
[79]	Pepper, Ribisl, Emery and Brewer [79]	n = 3878	U.S.	Self-report (n = 3878) Types of user as defined by authors: 'Current use: using e-cigarettes either every day or some days. Ever use: trying or starting, even one puff. Adults (18 years or older) who ever tried e-cigarettes.'	PERCEPTIONS Perceived as less harmful (29%) and less harmful to others (23%) REASONS curiosity (53%), social environment (34%), to quit or cut back (30%), avoid smoking restriction (26%), unexpected benefits (42%), cravings (38%), affordable (28%), flavors (30%), routine maintenance (36%).
[80]	Peters, Meshack, Lin, Hill and Abughosh [80]	n = 47	U.S.	Qualitative research (focus groups n = 47) Types of user as defined by authors: age 15–17 years old male adolescent current e-cigarette users in Texas, U.S.	REASONS Aesthetics, accessibility, healthier than Cigarettes, Odorless, High Social Approval, Expeditious Consumption and Concealment, Safe High.
[81]	Pineiro, Correa, Simmons, Harrell, Menzie, Unrod, Meltzer and Brandon [81]	n = 1815	U.S.	Self-report (n = 1815) Types of user as defined by authors: 'Dual users: participants reporting using tobacco cigarettes in the past 30 days, that is, users of both tobacco cigarettes and e-cigarettes. E-cigarettes users: reported smoking no tobacco cigarettes in the past month.' 18 years or older; E-cigarette users	PERCEPTIONS taste, social environment, throat hit, weight control, addiction. REASONS smoking cessation tool, health benefit, curiosity, due to family/friends, Cut back smoking, enjoy taste, deal with stress. Self-regulation.
[33]	Pokhrel, Herzog, Muranaka and Fagan [33]	n = 62	U.S., Hawaii	Qualitative research (focus groups n = 62) Types of user as defined by authors: 'All participants' current daily e-cigarette users.' 18–35 years old; Current daily e-cigarette users and dual users	REASONS smoking cessation, health benefit, satisfaction, mimic smoking, cut back, avoid smoking restrictions, discreet (hiding use), hobby, social environment, costs

[82]	Pokhrel, Herzog, Muranaka, Regmi and Fagan [82]	N = 62	U.S., Hawaii	Qualitative research (focus groups n = 62): Types of user as defined by authors: 'All participants' current daily e-cigarette users. Former smokers: reported having smoked more than 100 cigarettes in the lifetime and non in the past 30 days. Current non-smokers: never smoked cigarettes or were former cigarette smokers. 18–35 years old; Current daily e-cigarette users and current dual users.' Dual users, 18 years or older	REASONS Dual use: to help with cravings, situational use, places, when other substances are used, need of an e-cigarette substitute. Activities (working, before work out), places/situations (home, inside a vehicle, when you don't want to smell), to avoid smoking restrictions
[32]	Rass, Pacek, Johnson and Johnson [32]	n = 350	U.S.	Cross-sectional (n = 350) Types of user as defined by authors: 'all participants were dual users of e-cigarettes and tobacco cigarettes.' Dual users, 18 years or older	PERCEPTIONS less harmful (57% much less, 30% some less), less harmful to others, less enjoyable than cigarettes, addictive, NRT perceived as equally harmful as e-cigarettes (59%). 30% not at all addictive, unsure about the dangers of e-cigarettes (22%), unsure about the dangers 22.0% REASONS less harmful 64%; To cut down smoking tobacco 40%; Avoid smoking restrictions 45%; To quit smoking 34%; cravings 57%; less harmful to others 52%; experienced health benefits 30%; costs 27%; taste 22%; Other (e.g., prefer the smell, reduce stress) 3%; withdrawal 35%; focus 8%; I can't stop using it 1%; With an e-cigarette, it is easier to just smoke one or a few puffs at a time rather than a whole cigarette 45%.
[83]	Richardson, Pearson, Xiao, Stalgaitis and Vallone [83]	n = 1487	U.S.	Legacy Longitudinal Smoker Cohort (n = 1487) Types of user as defined by authors: 'Current smoker: those who reported smoking 'every day' or 'some days'. Former smoker: those who reported smoking 'not at all'. Current and former smokers 18–49 years old'	PERCEPTIONS perceived as less harmful than combustible cigarettes overall (61.6% among smokers, 79.2% among ever users, and 65.4 % among aware but non users). REASONS 55.3% cut back or smoking cessation, 38.1%, avoid smoking restrictions, feels like smoking (62.8%), with former smokers more likely than current smokers (35.5% vs. 16.8%). cost (59.6%), social environment (69.6%), no lingering odor (61.7%). avoid smoking bans (69.0%), with former smokers more likely than current smokers to cite this as a reason for use (92.6% vs. 65.4%).
[84]	Rutten, Blake, Agunwamba, Grana, Wilson, Ebbert, Okamoto and Leischow [84]	n = 2254	U.S.	Cross-sectional (n = 2254) Types of user as defined by authors: 'Current smokers: had smoked 100 or more cigarettes during their life and smoke cigarettes currently. E-cigarette users: use e-cig on some days or every day. 18 years or older; Current smokers'	REASONS Reduce health risks 51.9%; Quit smoking 58.4%; Reduce smoking 57.9%; Appealing flavor 14.7%; Not as strong, lighter 15.9%; Addicted to e-cigarettes 7.099%; Curious 16.0%; Stress reduction 11.9%; Cost less 24.5%; Can smoke indoors 46.8%; Less harmful to others 32.9%;
[85]	Saddleson, Kozlowski, Giovino, Goniewicz, Mahoney, Homish and Arora [85]	(n = 429)	U.S.	Cross-sectional (n = 1437) subsample (n = 429) Types of user as defined by authors: 'current use: past 30 days divided in current daily (all 30 days) and current non-daily (1 to 29 days of the previous 30 days) users. Discontinued e-cigarette user: ever used, but not in the previous 20 days. Never	PERCEPTIONS less toxic (46.5%) REASONS pleasure/enjoying use 57.9%, social environment (20.4%), alternative way of tobacco consumption (18.5%), smoking cessation (14.1%), cravings (13.6%), do not smell like smoke (39.2%), costs (24.9%), to try something new (71.6%), to try something new and to help control

				smokers: never tried a tobacco cigarette, not even a puff. Experimenters: have smoked less than 100 cigarettes in lifetime, and did not smoke any cigarettes in the past 30 days. Discontinued smokers: smoked 100 or more cigarettes in lifetime, but did not smoke any cigarettes in the past 30 days. Current smokers: have smoked at least 1 day out of the past 30 days. 18–23 years old, 29.8% e-cig ever users.'	appetite (9.1%), I am addicted to the e-cig and because all other smoking cessation methods had failed (5.3%).
[86]	Saddleson, Kozlowski, Giovino, Hawk, Murphy, MacLean, Goniewicz, Homish, Wrotniak and Mahoney [86]	n = 1437	U.S.	Self-report (n = 1437) Types of user as defined by authors: 'Current use: use on one or more days the past 30 days. Ever use: Have you ever tried or experimented with an e-cigarette, even one or two puffs? Never smoker: never tried a tobacco cigarette. Former smokers: smoked 100 or more cigarettes in lifetime, and have smoked 0 out of past 30 days. Experimenters: have ever tried a cigarette, have smoked less than 100 cigarettes in lifetime and have smoked 0 of the past 30 days. Current smoker: have smoked at least 1 day out of the past 30. 18–23 years old; general population; reports dual use for smokers'	PERCEPTIONS E-cigarettes are less harmful than tobacco cigarettes: ever e-cig users (32.8%), current (16.3%), never (42.4%).
[87]	Schmidt, Reidmohr, Harwell and Helgerson [87]	n = 5067	U.S.	Adult Tobacco Survey (self-report) cross sectional data of noninstitutionalized Montana adults. Types of user as defined by authors: "Have you ever used an electronic cigarette, even just one time in your entire life?" → ever use "Do you now use electronic cigarettes every day, some days → current e-cigarette users. Adult (18+) ever users of e-cigarettes (who answered the questions regarding REASONS)'	REASONS curiosity, to quit, less harmful, less disturbing, to avoid smoking bans, taste, costs.
[88]	Sherratt, Marcus, Robinson, Newson and Field [88]	n = 319	UK	Cross-sectional (n = 319) Types of user as defined by authors: 'Current smokers: smoked one or more cigarettes within the past week. Recent former smokers: did not smoke one or more cigarettes within the past week. Ever e-cigarette use: have ever used an electronic cigarette. Current e-cigarette use: having used an e-cigarette within the past month. Former e-cig user: used within the past 1-6 months or more than 6 months ago. current smokers: Stop smoking service, 18–60 years old'	PERCEPTIONS 48.2% perceived e-cig as less harmful than tobacco. 38.8% felt uncertain about e-cig safer than tobacco. Current users viewed e-cig as less harmful than former or never users.

[89]	Sherratt, Newson, Marcus, Field and Robinson [89]	n = 20	UK	Qualitative interviews (n = 20). Types of user as defined by authors: 'With participants of Stop Smoking Services in north-west England. Both individuals who had tried e-cigarettes (n = 6) and those who had not (n = 14). Median age was 51.5 years (range 25–59). Recent former smokers: they had not smoked within at least the last 7 days)'	PERCEPTIONS e-cigarette users perceive e-cigarettes as safer than smokers. E-cigarettes were perceived as an effective smoking cessation aid. Reduce cravings and helps to sustain abstinent from tobacco.
[90]	Simmons, Quinn, Harrell, Meltzer, Correa, Unrod and Brandon [90]	n = 31	U.S.	Qualitative research (focus groups n = 31). With e-cigarette users. Types of user as defined by authors: '(1) ≥ 18 years old; (2) had smoked cigarettes daily for at least 1 year; and (3) had used e-cigarettes in the past 30 days.'	PERCEPTIONS perceived health benefits. REASONS to quit smoking initially. Interest and satisfaction from experimenting with several aspects of e-cigarette devices.
[91]	Soule, Rosas and Nasim [91]	n = 108	U.S.	Concept mapping (CM) to characterize and describe adults' REASONS for using ECIGs. Types of user as defined by authors: 'A total of 108 adults completed a multi-module online CM study that consisted of brainstorming statements. E-cigarette use was described as past 30-day use. 18 years or older and used e-cigarettes in the past month.'	REASONS Cessation Methods, perceived health benefits, private regard, convenience, conscientiousness, and pleasurable effects, perceived agency, therapeutic, hobby, and social impacts.
[92]	Suris, Berchtold and Akre [92]	n = 621 (248 e-cigarette users)	Switzerland	Longitudinal research (self-report (n = 621) Types of user as defined by authors: 'Current smoker: smoking at least weekly. Experimenters: only used once. Adolescent (14–16 years old). Users (experimenters and regular users) were asked about REASONs'	REASONS Curiosity 93.1% (experimenters)–76.8% (users); avoid smoking restrictions 3.2% (experimenters)–14.4% (users); To reduce smoking 3.6% (experimenters)–10.4% (users); To do like my friends 5.1% (experimenters)–6.0% (users); To smoking cessation 0.0% (experimenters)–3.3% (users).
[93]	Tan and Bigman [93]	n = 3630	U.S.	Health Information National Trends Survey (n = 3630); cross-sectional Types of user as defined by authors: 'Non-smoker: respondents who have never smoked up to 100 cigarettes in their lives. Former smokers: Those who smoked at least 100 cigarettes in their lives but were currently not smoking at all. Current smokers: those who smoked at least 100 cigarettes in their lives and were smoking daily or on some days. 18 years or older; general population'	PERCEPTIONS decline in harm perception among current: believed e-cigarettes are less harmful than smoking (84.7% in 2010 to 65.0% in 2014). Believe e-cigarette as less harmful 49.5%former smokers, 45.9 % non-smokers, and 65.0% current smokers.
[94]	Tan, Lee and Bigman [94]	n = 527	U.S.	Self-report (n = 527) Types of user as defined by authors: 'Ever users: comprising those tried but not in the past 30 days, and those used in the past 30 days, even just one time.' 18–87 years old; general population.	PERCEPTIONS Harmful to others 42.8% Non-users; 26.2% ever-users; addictive 52.5% Non-users; 40.9% ever-users; Gateway effect 55.1% Non-users; 43.1% ever-users; Socially acceptable 61.6% Non-users; 38.5% ever-users; Less harmful than smoking 32.4% Non-users; 56.9% ever-users; Smoking cessation 31.9% Non-users; 52.3% ever-users; Less

					harmful to others 38.9% Non-users; 57.6% ever-users; make smoking look acceptable to youth never smokers;35.7%, former smokers 46.7%, current smokers 36.1%
[95]	Trumbo and Harper [95]	n = 244	New-Zealand	Cross-sectional (n = 244) Types of user as defined by authors: Ever tried and regular use not specified; 19–22 years old; not specified	PERCEPTIONS students found it socially acceptable to use e-cigarettes in public places. Overall negative attitude, pressure to use an e-cigarette
[96]	[96]	n = 3241	U.S.	Longitudinal research (survey 7-monght follow-up). Types of user as defined by authors: 'Ever use of e-cigarettes (n=2476 are included in the analysis). "Have you ever used e-cigarettes, electronic, or vapor cigarettes?" adult ever users of e-cigarettes (18+)'	REASONS to quit, to replace tobacco cigarettes, to cut down, to avoid smoking bans, curiosity, deal with cravings, less harmful, recommendation, costs
[97]	Wackowski, Bover Manderski and Delnevo [97]	n = 519	U.S.	Cross-sectional (n = 519) Types of user as defined by authors: 'current smokers: have ever smoked 100 cigarettes and now smoke some days or every day. Current e-cigarette users: those who had used e-cigarettes in the past 30 days. Former e-cigarette users/triers: those who had ever tried e-cigarettes but not used them in the past 30 days. Current Cigarette smokers 18 years or older.'	PERCEPTIONS 59.9% of smokers believed e-cigarettes are less harmful. More prevalent among current e-cig users (82.8%) than former (63.9%) or never (48.6%)
[98]	Wackowski, Bover Manderski, Delnevo, Giovenco and Lewis [98]	n = 509	U.S.	Self-report (survey n = 509) among adult (18 years or older) Types of user as defined by authors: 'current smokers defined as having ever smoked 100 cigarettes and now smoking "some days" or "everyday" in the U.S. Those smokers who had also used e-cigarettes in the past 30 days as "current e-cigarette users/triers". Those who had ever tried e-cigarettes but not used them in the past 30 days as "former e-cigarette users/triers".'	REASONS believed it was less harmful than regular cigarettes (77.2%), out of curiosity (76.5%), as a way to cut down on smoking (72.7%), cigarette smoking cessation (64.9%), to use in places where they can't smoke (66.7%). Current e-cigarette users/triers reported more often cutting down on smoking, saving money and consideration for others as REASONS for trying e-cigarettes. Curiosity was the main reason for trying e-cigarettes among former users/triers (77.1%).
[99]	Wang, Li, Jiang, Chu, Kwong, Lai and Lam [99]	n = 1307	Hong Kong	Cross-sectional (n = 1307) Types of user as defined by authors: 'Daily smokers; 4 ppm or above exhaled carbon monoxide. Ever use: ever used, even a single puff, age 18 years or older. 18 years or older; daily smokers'	PERCEPTIONS 11.0% perceived is as an effective smoking cessation tool. 74.1% (users) and 91.2% (non-users) did not think of them as effective for smoking cessation.
[100]	White, Li, Newcombe and Walton [100]	2012 n = 3127, 2014 n = 2919	New-Zealand	Youth Insights Survey (2012: n = 3127; 2014: n = 2919); cohort Types of user as defined by authors: 'Current smokers; smoked at least once a month or more	REASONS curiosity (64.5%), recommended by someone (24.2%), safer than tobacco (27.8%), avoid smoking restrictions (16.3%), cut back on cigarettes (18.4%), smoking cessation (16.6%), costs (not specified). Curiosity: infrequent smokers (67.1%) and ex-smokers (62.4%). Harm

				often. Infrequent smokers; less often than once a month. Ex-smokers; had smoked a cigarette, but no longer smoke. Ever use: have ever tried electronic cigarettes. 14–15 years old; not stratified (ever users are asked reasons why)'	reduction: 42.5% infrequent smokers having first tried e-cigarettes for this reason.
[101]	Yong, Borland, Balmford, Hitchman, Cummings, Driezen and Thompson [101]	n = 2105	Australia & UK	International tobacco control four country ITC project, Australia & UK 2013 (n = 2105). Longitudinal data. Types of user as defined by authors: 'E-cigarette use: "Have you ever tried an electronic cigarette?" Those who had tried: "How often, if at all, do you currently use an electronic cigarette?" with the response options "Daily, Less than daily, Less than weekly, Less than monthly or Not at all".'	PERCEPTIONS Australia: a lot less harmful compared to conventional cigarettes 36% of the smokers. UK: a lot less harmful compared to conventional cigarettes 57.6% of the smokers.
[102]	Zhu, Gamst, Lee, Cummins, Yin and Zoref [102]	n = 10,041	U.S.	Cross-sectional n = 10,041 Types of user as defined by authors: 'Current smoker; had at least smoked 100 cigarettes in their lifetime and answered the question 'Do you currently smoke cigarettes every day, some days, or not at all?' with every day or some days. Former smokers; those who smoked at least 100 cigarettes in their lifetime and answered 'not at all'. Non-smoker: those who had not smoked 100 cigarettes in their lifetime. Ever use: those who have ever tried an e-cigarette. Current user: those who had used e-cigarettes in the last 30 days. 18 years or older; general sample, reasons among e-cig users'	REASONS Safer than cigarettes 49.9%; Cheaper than cigarettes 30.3%; Easy to use when I can't smoke 44.8%; To try to quit smoking cigarettes 54.9%; Just because 68.3%

Appendix C: Literature Abstraction Tables

Flavor Ban Studies:

Unadjusted Percentages from Flavor Ban Studies

Reference	Metric	Unadjusted measures	
Courtemanche et al. (2017)		*Pre-ban*	*Post-ban*
	Any cigarettes past 30 days (%)	14.0	9.3
	Among cigarette users: Cigarettes in past 30 days (average count)	113.215	98.366
	Among cigarette users: Usually smoke menthols (%)	45.3	52.5
	Any cigars past 30 days (%)	7.7	7.7
	Any smokeless tobacco past 30 days (%)	4.2	4.1
	Any pipe smoking past 30 days (%)	2.3	2.8
	Any cigars, smokeless, or pipe past 30 days (%)	10.2	10.7
	Any cigarettes, cigars, smokeless, or pipe past 30 days (%)	17.9	14.4
Farley and		*Pre-ban*	*Post-ban*

Johns (2017)	Current smoking (%)	7.3 (95% CI: 4.6 to 11.5)	7.6 (95% CI: 6.5 to 8.9)
	Current cigarillo use (%)	5.7 (95% CI: 3.9 to 8.3)	7.1 (95% CI: 6.2 to 8.2)
	Current smokeless use (%)	3.5 (95% CI: 2.3 to 5.3)	4.0 (95% CI: 3.3 to 4.9)
	Ever menthol cigarette use (%)	12.1 (95% CI: 8.6 to 16.8)	9.3 (95% CI: 7.7 to 11.1)
	Ever flavoured use (%)	19.6 (95% CI: 16.4 to 23.2)	15.6 (95% CI: 13.7 to 17.8)
Nguyen and Grootendorst (2014)		*Pre-ban*	*Post-ban*
	Age 15-24		
	Past 30-day use of cigarillos (%)	Males: 13.7 (95% CI: 12.1 to 15.3)	Males: 9.3 (95% CI: 8.1 to 10.5)
		Females: 5.3 (95% CI: 4.3 to 6.3)	Females: 3.3 (95% CI: 2.5 to 4.0)
	Past 30-day use of regular cigars (%)	Males: 5.8 (95% CI: 4.8 to 6.8)	Males: 4.9 (95% CI: 4.0 to 5.8)
		Females: 0.8 (95% CI: 0.4 to 1.2)	Females: 0.9 (95% CI: 0.5 to 1.4)
	Age 25-65		
	Past 30-day use of cigarillos (%)	Males: 4.2 (95% CI: 3.1 to 5.2)	Males: 4 (95% CI: 2.9 to 5.1)
		Females: 1.8 (95% CI: 1.1 to 2.4)	Females: 1.1 (95% CI: 0.6 to 1.5)
	Past 30-day use of regular cigars (%)	Males: 2.6 (95% CI: 1.8 to 3.5)	Males: 2.1 (95% CI: 1.5 to 2.7)
		Females: 0.1 (95% CI: 0.0 to 0.3)	Females: 0.1 (95% CI: 0.0 to 0.3)

Adjusted Flavor Ban Study Results

Reference	Population	Confounders considered	Metric	Measure	Significance
Courtemanche et al. (2017)	11-19 year olds	Time trends, age, unemployment rate, tobacco	Odds ratio of any cigarettes in past 30 days post-ban compared to pre-ban	0.829 (SE: 0.0202)	p<0.001

prices	Among smokers: percent change of odds of cigarettes used in past 30 days post-ban compared to pre-ban	-0.585 (SE: 0.210)	p<0.01
	Among smokers: Odds ratio of usually using menthol cigarettes post-ban compared to pre-ban	1.448 (SE: 0.0616)	p<0.001
	Odds ratio of any cigars in past 30 days post-ban compared to pre-ban	1.344 (SE: 0.0422)	p<0.001
	Odds ratio of any smokeless tobacco in past 30 days post-ban compared to pre-ban	1.064 (SE: 0.0677)	NS
	Odds ratio of any pipe smoking in past 30 days post-ban compared to pre-ban	1.546 (SE: 0.0626)	p<0.001
	Odds ratio of any cigars, smokeless tobacco, or pipe in past 30 days post-ban compared to pre-ban	1.142 (SE: 0.0249)	p<0.001
	Odds ratio of any cigarettes, cigars, smokeless tobacco, or pipe in past 30 days post-ban compared to pre-ban	0.939 (SE: 0.0086)	p<0.001

Farley and Johns (2017)	13-17 year olds	Sex, Race/ethnicity, age, cigarette smoker, cigarillo smoker, smokeless tobacco user, metnhol cigarette user	Odds ratio of ever flavored use post-ban compared to pre-ban	0.63 (95% CI: 0.52-0.77)	p<0.05
			Odds ratio of any flavored use post-ban compared to pre-ban	0.72 (95% CI: 0.62-0.85)	p<0.05
			Odds ratio of current smoking post-ban compared to pre-ban	1.31 (95% CI: 0.94-1.84)	NS
Nguyen and Grootendorst (2014)	15-65 year olds	Education, age, sex, summer season, household size, language, province	***Ages 15-24***		
			Percent point change in intercept		
			Cigarillo past 30-day use	-0.0229 (SE: 0.0053)	p<0.01
			Cigarillo 30-day abstinence	0.0432 (SE: 0.0189)	p<0.05
			Cigarillo ever-use	-0.0308 (SE: 0.0055)	p<0.01
			Regular cigar past 30-day use	0.001 (SE: 0.003)	NS
			Regular cigar ever use	-0.0063 (SE: 0.0045)	NS
			All cigar types ever use	-0.0225 (SE: 0.006)	p<0.01
			Change in trend		
			Cigarillo past 30-day use	-0.0001 (SE: 0.0003)	NS
			Cigarillo 30-day abstinence	0.0001 (SE: 0.0007)	NS
			Cigarillo ever-use	-0.0003 (SE: 0.001)	NS
			Regular cigar past 30-day use	0.0008 (SE: 0.0003)	p<0.05
			Regular cigar ever use	0.0022 (SE: 0.0004)	p<0.01
			All cigar types ever use	-0.0001 (SE: 0.0011)	NS
			Pre-policy trend		

Cigarillo past 30-day use	-0.0003 (SE: 0.0003)	NS
Cigarillo 30-day abstinence	0.0011 (SE: 0.0006)	NS
Cigarillo ever-use	0.0007 (SE: 0.0002)	p<0.05
Regular cigar past 30-day use	-0.0007 (SE: 0.0002)	p<0.01
Regular cigar ever use	-0.0017 (SE: 0.0005)	p<0.01
All cigar types ever use	0.0001 (SE: 0.0003)	NS
Age 25-65		
Percent point change in intercept		
Cigarillo past 30-day use	-0.0006 (SE: 0.009)	NS
Cigarillo 30-day abstinence	-0.0002 (SE: 0.019)	NS
Cigarillo ever-use	-0.0116 (SE: 0.0194)	NS
Regular cigar past 30-day use	-0.0037 (SE: 0.001)	p<0.01
Regular cigar ever use	-0.0212 (SE: 0.0106)	p<0.1
All cigar types ever use	-0.014 (SE: 0.0169)	NS
Change in slope		
Cigarillo past 30-day use	-0.0001 (SE: 0.0006)	NS
Cigarillo 30-day abstinence	0.0003 (SE: 0.0017)	NS
Cigarillo ever-use	0.0012 (SE: 0.0009)	NS
Regular cigar past 30-day use	0.0004 (SE: 0.0002)	NS
Regular cigar ever use	0.0009 (SE: 0.001)	NS
All cigar types ever use	0.0017 (SE: 0.0016)	NS
Pre-policy trend		
Cigarillo past 30-day use	-0.0001 (SE: 0.0001)	NS

Cigarillo 30-day abstinence	0.0004 (SE: 0.0002)	p<0.1
Cigarillo ever-use	0 (SE: 0.0005)	NS
Regular cigar past 30-day use	-0.0002 (SE: 0.0001)	p<0.05
Regular cigar ever use	-0.0007 (SE: 0.0003)	p<0.05
All cigar types ever use	-0.0004 (SE: 0.0001)	p<0.05

NS: Statistically non-significant

DCE Studies

Unadjusted percentages for DCE studies

Reference	Metric	Measures	
Buckell et al. (2018)	Not available	Not available	
Czoli et al. (2016)	Not available	Not available	
Pesko et al. (2016)		*18-24*	*25+*
	Percent choosing tobacco/menthol ENDS	17.5	9.2
	Percent choosing flavored ENDS	21.9	9.9
Salloum et al. (2015)		Not available	
Shang et al. (2018)		Not available	

Adjusted DCE study results

Reference	Population	Confounders considered	Metric	Flavored Product	Measure	Statistical significance
Buckell et al. (2018)	2031 adult smokers and recent quiters	Price, nicotine, perception of health effects	**Younger adult (18-25 year olds)**			
			Change in log (odds ratio) of selecting flavored product compared to tobacco cigarettes when a young adult	Menthol cigarettes	0.37 (SE: 0.116)	p<0.01
				Tobacco e-cigarettes	0.26 (SE: 0.099)	p<0.01
				Menthol e-cigarettes	0.41 (SE: 0.139)	p<0.01
				Fruit/sweet e-cigarettes	0.61 (SE: 0.109)	p<0.01
			Older adult (54-64 year olds)			
			Change in log (odds ratio) of selecting flavored product compared to tobacco cigarettes when an older adult	Menthol cigarettes	-0.52 (SE: 0.112)	p<0.01
				Tobacco e-cigarettes	-0.2 (SE: 0.086)	p<0.05
				Menthol e-cigarettes	-0.19 (SE: 0.129)	NS
				Fruit/sweet e-cigarettes	-0.62 (SE: 0.107)	p<0.01
Czoli et al. (2016)	915 Canadians aged 16 years and older	Price, Health Warning, Nicotine	**Overall**			
			Log (odds ratio) for intention to try compared to "mean in the design and in the marketplace."	Tobacco	-0.19 (SE 0.02)	p<0.0001
				Menthol	0.04 (SE 0.02)	p<0.01
				Coffee	0.02 (SE 0.02)	p=0.37
				Cherry	0.13 (SE 0.02)	p<0.0001
			Log (odds ratio) for perception of lower product harm compared to "mean in the design and in the marketplace."	Tobacco	-0.58 (SE 0.02)	p<0.0001
				Menthol	0.42 (SE 0.02)	p<0.0001
				Coffee	0.19 (SE 0.02)	p<0.0001
				Cherry	-0.03 (SE 0.02)	p=0.07
			Log (odds ratio) for	Tobacco	-0.12 (SE 0.02)	p<0.0001

	perceptions of greater product quit efficacy compared to "mean in the design and in the marketplace."	Menthol	0.15 (SE 0.02)	p<0.0001
		Coffee	0.08 (SE 0.02)	p<0.0001
		Cherry	-0.11 (SE 0.02)	p<0.0001
	Non-Smokers aged 16-24			
	Change in intention to try	Coffee	NG	p<0.01
		Cherry	NG	p<0.0001
		Menthol	NG	p<0.001
		Tobacco	NG	NS
	Change in perception of lower product harm	Coffee	NG	p = 0.02
		Cherry	NG	NS
		Menthol	NG	NS
		Tobacco	NG	NS
	Change in perceptions of greater product quit efficacy	Coffee	NG	p = 0.01
		Cherry	NG	NS
		Menthol	NG	NS
		Tobacco	NG	NS
	Smokers aged 16-24			
	Change in intention to try	Coffee	NG	NS
		Cherry	NG	p<0.001
		Menthol	NG	NS
		Tobacco	NG	NS
	Change in perception of lower product harm	Coffee	NG	NS
		Cherry	NG	p = 0.03
		Menthol	NG	NS
		Tobacco	NG	NS
	Change in perceptions of greater product quit efficacy	Coffee	NG	NS
		Cherry	NG	p = 0.02
		Menthol	NG	NS
		Tobacco	NG	NS
	Smokers aged 25+			
	Change in intention to try	Coffee	NG	NS
		Cherry	NG	NS
		Menthol	NG	NS
		Tobacco	NG	p<0.0001

			Change in perception of lower product harm	Coffee Cherry Menthol Tobacco	NG NG NG NG	NS NS NS p<0.001
			Change in perceptions of greater product quit efficacy	Coffee Cherry Menthol Tobacco	NG NG NG NG	NS NS NS p=0.01
Pesko et al. (2016)	1200 Adults aged 18 years or older	Price, Warning, Used vaping in last month, quit interest above median level, gender, race/ethnicity, education, income, labor participation, marriage status, household size, metro area, region, survey duration	Change in probability of young adults (18-24) selecting tobacco ENDS compared to older adults (25+)	Tobbaco	0.103 (95% CI: 0.044-0.162)	p<0.001
			Additional change in probability for younger adults (18-24) selecting flavored ENDS compared to probability of younger adults selecting tobacco ENDS	Non-tobacco flavor	0.037 (95% CI: 0.02-0.055)	p<0.001
Salloum et al. (2015)	367 college students at least 18 years of age	Nicotine, Price	Log (odds ratio) of selecting flavor compared to grand mean product	Double Apple Blue Mist Pirate's Cave Tobacco	0.9423 (SE: 0.0369) 0.5024 (SE: 0.0381) 0.0496 (SE: 0.0404) -1.494 (SE: 0.0606)	p< 0.001 p< 0.001 NS p< 0.001
Shang et	515	Device type,	***Ever Users of ENDS***			

al. (2018)	adolescents aged 14-17 years.	warning, gender, age, race/ethnicity, family income, household size, parent's education, current smoking status	Log(odds ratio) of selection of flavored ENDS compared to selection of tobacco ENDS	Flavored (menthol or fruits/sweets/beverage):	0.682 (SE: 0.376)	NS
				Menthol:	0.065 (SE: 0.68)	NS
				Fruit/sweets/beverage:	1.277 (SE: 0.699)	NS
			Never Users of ENDS			
			Log(odds ratio) of selection of flavored ENDS compared to selection of tobacco ENDS	Flavored (menthol or fruits/sweets/beverage):	0.497 (SE: 0.112)	p <0.01
				Menthol:	0.443 (SE: 0.209)	p <0.05
				Fruit/sweets/beverage:	0.98 (SE: 0.232)	p <0.01

NG: Not given
NS: Not statistically significant