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Adolescent's Health Perceptions of E-Cigarettes: A Systematic Review
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Abstract:	<p>ABSTRACT</p> <p>Context: E-cigarette use is increasing among adolescents, particularly in high-income countries. This review examined the health perceptions of e-cigarettes among adolescents (12-17 years) residing in the US, United Kingdom, Canada, Australia, and New Zealand, and their sources of e-cigarette information.</p> <p>Evidence Acquisition: Peer-reviewed literature published January 2009 – April 2019 in Medline, Embase and ProQuest were systematically reviewed using identified keywords. The search identified 654 references. Studies (n=99) that met the inclusion criteria were subject to full-text screening. Twenty-seven articles were subject to quality appraisal using The Joanna Briggs Institute's critical appraisal checklists.</p> <p>Evidence Synthesis: Seven qualitative and 18 quantitative studies were included in the review and the study characteristics, results, and limitations were extracted. Four main themes emerged from the study findings, (1) perceived relative harm of e-cigarettes versus cigarettes, (2) perceived health effects of e-cigarettes, (3) perceived benefits and safety of e-cigarettes, and (4) sources of e-cigarette information and exposure. Most adolescents perceived e-cigarettes to be less harmful than cigarettes, however, often their health perceptions of e-cigarettes were conflicting. Exposure to e-cigarette information included friends, family, retail point of sale, television and online advertising, national agencies, healthcare providers and via direct experience.</p> <p>Conclusions: Findings indicate that adolescents, particularly e-cigarette users, have more favourable perceptions of e-cigarettes compared to cigarettes, however, these perceptions were conflicting. Advertising, marketing, and peer and family networks appear to influence adolescents' perceptions. More research is required, particularly in Australia and New Zealand to better understand adolescents' health perceptions of e-cigarettes and where they source information, so misperceptions can be addressed through appropriate channels with suitable messaging.</p>
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Adolescent's Health Perceptions of E-Cigarettes: A Systematic Review

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Context: E-cigarette use is increasing among adolescents, particularly in high-income countries.

This review examines the health perceptions of e-cigarettes among adolescents (aged 12–17 years) residing in the U.S., United Kingdom, Canada, Australia, and New Zealand, and their sources of e-cigarette information.

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Conclusions: Findings indicate that adolescents, particularly e-cigarette users, have more favorable perceptions of e-cigarettes compared with cigarettes; however, these perceptions are conflicting. Advertising, marketing, and peer and family networks appear to influence adolescents’ perceptions. More research is required, particularly in Australia and New Zealand, to better understand adolescents’ health perceptions of e-cigarettes and where they source information, so misperceptions can be addressed through appropriate channels with suitable messaging.

CONTEXT

E-cigarettes are battery-operated devices containing a liquid (e-liquid) usually comprising an amalgamation of nicotine, flavored compounds, propylene glycol and glycerine, which once heated forms an aerosol that users inhale.¹ After being introduced to the American market in the mid-2000s,¹ they were primarily manufactured and marketed globally by independent e-cigarette companies.² However, e-cigarettes have since undergone rapid diversification and investment from the tobacco industry² and there are now 3 broad classifications of e-cigarettes—disposables (device is discarded after e-liquid is exhausted), closed reusable systems (user purchases prefilled e-liquid cartridges), and open reusable systems (device contains a tank reservoir that users refill with e-liquids of their choice).³ Many of the disposable and early edition pen-style systems were designed to mimic the design of cigarettes. Recently, the tobacco company Altria acquired e-cigarette brand JUUL,⁴ transforming the e-cigarette marketplace by developing a USB-shaped device that uses novel chemistry (nicotine salts), enabling higher nicotine concentrations in a limited aerosol plume.⁵

The increased uptake of e-cigarettes⁶ among American adolescents has been hailed an “epidemic” by the U.S. Surgeon General, public health leaders, and the former U.S. Food and Drug Administration Commissioner.^{7,8} In 2020, a total of 3.6 million American adolescents, including 19.6% of high school students and 4.7% of middle school students, used e-cigarettes (≥ 1 day in the past 30 days).⁹ Increased rates of vaping among adolescents in Canada,¹⁰ New Zealand (NZ),¹¹ the United Kingdom (UK),¹² and Australia¹³ have also been documented, although not to the same extent as in the U.S. The differences in adolescent uptake among these countries could be attributed to the diverse regulatory frameworks the countries have implemented.¹⁴

The popularity and variety of available flavored e-cigarettes¹⁵ are a primary concern regarding the public health implications of these products. Numerous studies have demonstrated that candy-, fruit-, and menthol-flavored e-cigarettes are appealing to adolescents¹⁶⁻¹⁹ and, widespread and unregulated availability of e-cigarettes may facilitate youth nicotine addiction, replicate smoking behaviors, and result in the use of conventional tobacco products.^{20,21}

Adolescents may initiate e-cigarette use as they perceive them to be less harmful or less addictive than cigarettes,^{22,23} especially in the context of attractive and seemingly harmless flavors.²⁴ A recent systematic review found an increase in e-cigarette marketing expenditure and online engagement through social media and concluded that exposure to e-cigarette marketing may be associated with lower harm perceptions of e-cigarettes, and adolescent' intention to use and try e-cigarettes.²⁵

The National Academies of Sciences, Engineering, and Medicine report e-cigarettes contain fewer and lower levels of toxicants than cigarettes and pose less risk to individuals because they do not contain tobacco and no combustion is involved.²⁶ Furthermore, e-cigarettes may potentially reduce harm among current smokers if they completely transition to e-cigarettes and abstain from cigarettes.²⁶ However, evidence also indicates these products are not entirely harmless.²⁷ This is particularly pertinent to adolescents, with the U.S. Surgeon General declaring e-cigarette use as “unsafe, even if they do not progress to future cigarette smoking.”⁸ Nicotine exposure during adolescence can have detrimental effects on the developing brain, affecting learning, memory, and attention capabilities.¹ Additionally, e-cigarette use can expose both users and bystanders to aerosols containing harmful substances including heavy metals, volatile organic compounds, and ultrafine particles.¹

Given the conflicting discourse surrounding e-cigarettes^{28,29} in the media, academia, and political arena, it is critical to understand adolescents' health perceptions of e-cigarettes and the sources they use to obtain e-cigarette information. To the best of the authors' knowledge, this is the first study to systematically review literature examining the health perceptions of e-cigarettes among adolescents aged 12–17 years living in the U.S., UK, Canada, Australia, and NZ.

Electronic vaporizers are referred to by a multitude of names³⁰ by retailers, consumers (e.g., mod, vape, e-hookah) and in the academic literature (e.g., electronic nicotine delivery device, nicotine vaping products). This paper uses the term e-cigarette to include the various electronic vaporizers that are available.

EVIDENCE ACQUISITION

This systematic review (without meta-analysis) was prospectively registered with PROSPERO (International Prospective Register of Systematic Reviews³¹; registration number CRD42019131253) on April 18, 2019 and it adhered to the PRISMA checklist.³²

Search Strategy Development

The search was guided by the SPIDER framework: sample, phenomenon of interest, design, evaluation, and research type.³³ The sample (target group) included adolescents aged 12–17 years living in the U.S., UK, Canada, Australia, or NZ. The phenomenon of interest (behaviors, experiences, and interventions) was health perception of e-cigarette use. Design (study designs) included all study designs. The evaluation (outcome measures) was health perceptions (attitudes, beliefs, and knowledge). Research type (of research studies) included peer-reviewed qualitative and quantitative studies.

Perception is defined as a “belief or opinion often held by people based on how things seem,”³⁴ is closely related to attitudes,³⁵ and is influenced by previous knowledge.³⁶ Therefore, to ensure that relevant data were collected on perceptions, the terms *knowledge*, *attitude*, and *belief* were included in the search strategy.

Eligibility Criteria

Eligible articles were peer-reviewed primary research studies (quantitative or qualitative) published in English between January 2009 and June 2019. Articles characterized as literature reviews, systematic reviews, meta-analyses, grey literature, editorials, and thesis publications were excluded. There are various definitions of youth and adolescence, with the terms used interchangeably.³⁷ The WHO defines “young people” (term combining adolescents and youth) as those aged 10–24 years and “adolescents” as those aged 10–19 years,³⁷ and the National Strategy for Young Australians defines “young people” as those aged 12–24 years.³⁸ Additionally, the medical subject heading *adolescent* is defined as “a person aged 13–18 years.”³⁹ As 18-year-olds in Australia,⁴⁰ Canada,⁴¹ and the UK⁴² are legally adults, the authors defined this study’s age range as 12–17 years. The review only included studies of adolescents aged 12–17 years from the U.S., UK, Canada, Australia, and NZ. These are high-income countries as defined by the World Bank,⁴³ their predominant language is English,⁴⁴ and they have relatively similar health profiles.⁴⁵ Studies reporting the inclusion of participants both within and outside the age criteria were included if the results were reported separately for adolescents aged 12–17 years. Articles reporting adolescents’ perceptions of e-cigarettes before the application of an intervention were also included.

Information Sources and Search Strategy

The Curtin University Faculty Librarian guided the identification of appropriate scholarly

databases (i.e., MEDLINE, ProQuest, and Embase). An initial search of the keywords *e-cigarette* and *knowledge* was conducted in MEDLINE, followed by an analysis of the keywords used in the titles of retrieved studies, and the associated indexed terms and medical subject headings that assisted in developing the search strategy.

The final search strategy was: (*“electronic cigarette*” OR e-cigarette* OR “electr* nicotine delivery system*” OR “personal vapo?ri?er*” OR “electr* nicotine delivery device*” OR “vape pen” OR e-hookah OR JUUL OR vap**) AND (*adolescen* OR youth* OR teen* OR “middle school*” OR “high school*” OR juvenile**) AND (*“health knowledge” OR “health literacy” OR “health knowledge, attitudes, and practice” OR perception* OR “health risk perception*” OR knowledge OR belief* OR “harm perception*” OR “perceived harm*” OR attitude**).

Selection Process

The search strategy results are presented in a PRISMA flow diagram (Figure 1). The search strategy was entered into each database on the May 1, 2019, and all retrieved citations (N=654) were imported into EndNote, version X8. Duplicate citations were removed (*n*=249). The remaining 405 citations were imported into Covidence, an online screening tool that guides reviewers through the key stages of the systematic review process.⁴⁶ Two reviewers (AS and KM) independently screened all titles and abstracts for eligibility, resulting in 309 excluded studies. Reviewer JJ resolved any uncertainties. Ninety-nine full texts were assessed for eligibility. Seventy-two studies were excluded owing to the country not meeting the inclusion criteria, did not examine research outcomes, adults being included only, and results for participants aged 12–17 years were not reported separately to those outside the review’s age range. Twenty-seven studies were quality appraised.

Quality Assessment and Data Extraction

The Joanna Briggs Institute critical appraisal checklists were used to assess the quality of studies (reliability, validity, trustworthiness, and credibility) as they were specific to the various study designs (qualitative research, analytical cross-sectional, cohort, and RCT [Appendix 1]) in this review.^{47,48} The Joanna Briggs Institute checklists have been approved by the Joanna Briggs Institute Scientific Committee following extensive peer review. AS and JJ assessed the quality of the studies. Reviewer KM resolved conflicts or uncertainties. Two studies did not meet the quality requirements and were excluded. Risk of bias was not assessed given the differing methodologies (qualitative and quantitative) of identified studies.

The data from 25 articles were extracted, guided by a data extraction proforma (Appendix Table 2). Information on the authors, year of study, study design, participants (age, sex, ethnicity, and e-cigarette user status), country of study, sample pool and size, sampling method, response rate, results, and limitations were extracted.

Data Analysis and Synthesis

The primary reviewer (AS) utilized thematic analysis to aggregate the data (qualitative and quantitative results) into broad themes. These themes were presented to 2 reviewers (JJ and KM) to further refine and ensure validity and credibility.⁴⁹ Particular descriptive quotes from qualitative studies were chosen for their ability to support the presented findings.

EVIDENCE SYNTHESIS

Characteristics of Included Studies

Included studies were conducted in the U.S. ($n=19$),^{16,50-67} UK ($n=5$),⁶⁸⁻⁷² and Canada ($n=1$).⁷³

No studies were identified as originating from Australia or NZ. Of the 25 included studies, 13 were cross-sectional,^{16,51–53,59–61,63,65–67,69,72} 7 were qualitative (grounded theory or phenomenological),^{50,56,62,68,70,71,73} 3 were cohort,^{54,58,64} and 2 were RCTs.^{55,57} Studies were published between 2013 and 2019, with data collected between 2012 and 2016. Sample size ranged from 25 to 24,658. The study characteristics and results are presented in Appendix Table 1.

Eleven studies used the same data sets.^{51,52,54,58–61,63,66,70,71} Five studies were published using the U.S. Population Assessment of Tobacco and Health data from 2013 to 2015.^{54,58,61,63,66} Two studies used data from the 2012 U.S. National Youth Tobacco Survey^{51,52} and 2 UK studies used data from the same focus groups.^{70,71} Furthermore, 2 studies analyzed the same online survey data collected in 2016.^{59,60}

The quantitative studies sampling methods included convenience sampling,^{55,57,59,60,64} stratified cluster sampling,^{51,52,65} cluster probability sampling,^{53,67} random location quota sampling,⁷² probability sampling,¹⁶ and stratified sampling.^{54,58,61,63,66,69} Quantitative data were collected using surveys (paper,^{51–53,64,65,72} online,^{55,57,59,60,67,69} phone¹⁶) and interviews (in person,⁷² audio computer assisted^{54,58,61,63,66}). The qualitative studies sampling methods included convenience sampling,^{50,62,73} stratified quota sampling with snowball sampling techniques,⁷³ and purposive sampling.^{56,70,71} Qualitative data were collected via focus groups,^{50,62,68,70,71,73} and telephone interviews.⁵⁶ The response rate of 11 studies (10 quantitative,^{16,51–54,63–67} 1 qualitative⁶⁸) ranged from 37% to 99%; 14 studies (8 quantitative,^{55,57–61,69,72} 6 qualitative^{50,56,62,70,71,73}) either did not report response rates or this was not applicable. Study limitations included self-reported data,^{51,52,54,56,58,64–66} small sample size,^{50,56,62,70,73} low response rate,^{16,67} non-generalizable data,^{50,51,55,56,60,62,65,67,69–71,73} and inability to show causality.^{52,63,66,69,72}

All studies included male and female participants in almost equal proportions, except for 1 that only included male young Americans who identified as e-cigarette users.⁶² Nine studies recruited through schools.^{51–53,62,64,65,67,68,73} Other approaches included online recruitment (including social media),^{59,60} household recruitment,⁷² and recruitment via a primary health setting⁵⁶ and community groups.^{70,71} Four studies included only e-cigarette users,^{50,59,60,62} 2 included those who had never used e-cigarettes,^{55,56} and 2 excluded cigarette users.^{53,66} Most studies ($n=16$) did not sample by smoking or e-cigarette use but included a breakdown of results by smoking or e-cigarette use.^{16,51,52,54,58,61,63–65,67–73}

All studies explored participants' perceptions of the harm or health effects of e-cigarettes,^{16,50–73} with 16 studies exploring perceptions relative to cigarettes.^{51–53,55,56,58,61–64,66–70,73} Twelve studies examined perceived benefits and appeal of e-cigarettes (e.g., flavors, social benefits, and stress reliever),^{16,50,53,55,56,62,63,66–70} 7 assessed knowledge of e-cigarettes (e.g., authors use words including “knowledge,” “know,” “knew”),^{50,56,59,60,68,70,73} 3 examined attitudes (e.g., how adolescents feel [e.g., good, bad, pleasant, annoying] toward e-cigarettes),^{16,57,73} and 4 explored beliefs about e-cigarettes (e.g., adolescents thinking e-cigarettes are cool, healthy, harmful).^{57,60–62}

Aggregated Results

Four key themes emerged from the study findings: (1) perceived relative harm of e-cigarettes versus cigarettes, (2) perceived health effects and safety of e-cigarettes, (3) perceived benefits of e-cigarettes, and (4) sources of e-cigarette information and exposure.

Perceived relative harm of e-cigarettes versus cigarettes. In 16 studies (64%; 11

quantitative,^{51–55,58,61,63,64,66,69} 5 qualitative^{56,62,68,70,73}), adolescents' perception of the harm from e-cigarettes compared with cigarettes was reported. Similarly, across all studies reporting proportions, at least one third reported e-cigarettes as being less harmful than cigarettes^{51–53,55,56,58,61,62,66,69} and specifically in national surveys conducted in the U.S.^{51,52,58,61,66} and UK,⁶⁹ this proportion ranged from 34% to 67%. One UK qualitative study⁶⁸ reported that e-cigarettes were less harmful than cigarettes owing to the vapor being evaporated water, “like a flavoured smoke,” containing fewer toxins, such as tar. However, in 4 U.S. quantitative studies, between 19% and 44% of adolescents reported e-cigarettes to be as harmful as cigarettes^{53,58,61,66} and fewer (3%–5%) reported e-cigarettes to be more harmful than cigarettes.^{52,53,58,66}

Of the 8 studies (7 quantitative,^{51–53,55,61,63,69} and 1 qualitative⁵⁶) that measured adolescents not knowing or being unsure whether e-cigarettes were more or less harmful than cigarettes, 2 quantitative studies (25%)^{52,53} reporting findings that disaggregated the adolescents' age conveyed that between 33% and 45% did not know how harmful e-cigarettes were compared with cigarettes. Further, the proportion of adolescents (U.S.) who had heard about e-cigarettes but did not know how harmful they were compared with cigarettes decreased as age increased (45% at age 13 years, 42% at age 16 years).⁵²

Dual users (using both cigarettes and e-cigarettes), cigarette-only smokers, and e-cigarette users were more likely to consider e-cigarettes to be less harmful than cigarettes compared with adolescents who did not smoke cigarettes or use e-cigarettes.^{51–53,62,64,69}

Perceived health effects and safety of e-cigarettes. Eighteen studies (72%)^{50,52,53,55,56,58–60,62,63,65–68,70–73} reported adolescents' perceptions of the health impact of e-cigarettes.

Adolescents believed e-cigarettes were either likely to harm health,^{53,55,56,63,65–68,70–73} did not

harm health (most likely to be e-cigarette users in 6 studies),^{50,53,58–60,62,73} or were unsure if there were any risks to health.^{50,52,68,73}

Adolescents in 10 studies (40%; 5 quantitative,^{53,55,63,67,72} 5 qualitative^{56,68,70,71,73}) reported e-cigarettes could have adverse health impacts. Large surveys of U.S. adolescents revealed that perceived health harm from using e-cigarettes was lower among e-cigarette users and cigarette users compared with non-users.^{53,63} Adolescents in the U.S. also reported that e-cigarettes had fewer short-term and long-term health risks compared with other tobacco products.⁶⁷ Nominated short-term health risks from e-cigarette use included lower sports performance (54%), trouble catching one's breath (52%), bad cough (47%), and mouth sores (42%).⁶⁷ Long-term health risks from e-cigarette use were tobacco-related disease (68%), lung cancer (61%), wrinkles (61%), oral cancer (57%), heart attack (57%), and tobacco-related death (56%).⁶⁷

Ten studies (40%; 5 quantitative,^{53,59,60,63,65} 5 qualitative^{50,58,62,71,73}) reported no perceived adverse health impacts from e-cigarettes. A respondent in a qualitative UK study cited that the National Health Service had “verified one [particular type of e-cigarette as] being safe to use,”⁷¹ as they perceived Medicines and Healthcare Products Regulatory Agency regulations as an official statement that medicinal e-cigarettes were safe. Parker et al.⁵⁸ (quantitative study) noted that youth who reported e-cigarettes as posing little or no harm were more than twice as likely to try them compared with youth who reported the products to pose a lot of harm. Furthermore, Pepper and colleagues⁵⁹ (quantitative study) found adolescents who use e-cigarettes reported that they were less likely to develop health problems in adulthood compared with cigarette smokers. E-cigarette users in a qualitative study⁵⁰ said they used e-cigarettes because they are “perfectly safe,” but would stop using them if they found out they were harmful to their health.

Three qualitative studies (12%) reported adolescents recognized a lack of evidence regarding the safety of e-cigarettes, which is why they reported that e-cigarettes were unsafe/harmful or were unsure about their health impact.^{70,71,73} For example, a 16-year-old male (current smoker, current vaper) said, “We need to find out a bit more about, like, the chemicals that are in it too, like, know whether you’d want to be around vapers.”⁷⁰

Bernat et al. (quantitative study) found that 36% of adolescents were unsure about the health impact of e-cigarettes.⁵³ Similarly, 4 qualitative studies (16%; UK, U.S., and Canada^{50,56,68,73}) reported adolescents were unsure about the health impact of e-cigarettes. Adolescents stated, “I feel like they’re going to find some study on them [e-cigarettes] that’s going to find them unhealthy and like cigarettes...”⁵⁰ (14–15-year-old) and “Nobody knows what’s in them” and that “[it] hasn’t been tested what’s inside them [e-cigarettes]...”⁶⁸ (13–16-year-olds).

Three studies (12%; 2 quantitative,^{53,67} 1 qualitative⁷⁰) reported that adolescents considered secondhand vapor from e-cigarettes to be unsafe for those exposed, although e-cigarette users had lower odds of reporting that e-cigarette vapor was harmful compared with never users.⁵³ Conversely, another quantitative study (U.S.) reported that approximately 31% of adolescents said e-cigarette vapor was not harmful to bystanders.⁵⁵ One Canadian quantitative study reported that adolescents were unsure about the safety of e-cigarette vapor.⁷³

Six studies (24%; 3 quantitative,^{53,63,66} 3 qualitative^{56,68,73}) identified that adolescents reported e-cigarettes to be addictive.^{53,56,63,66,68,73} The majority (61%) of U.S. high school students surveyed in 1 quantitative study also reported that people can become addicted to e-cigarettes.⁵³

Perceived benefits of e-cigarettes. Fourteen studies (56%; 8 quantitative,^{16,53–55,57,64,66,72} 6 qualitative^{50,56,62,68,70,73}) reported adolescents' perceptions of the benefits of e-cigarettes. The main perceived benefits of e-cigarettes were that they are healthy/healthier than cigarettes,^{56,57,62,64,68} e-cigarette vapor is safe for bystanders,^{55,62,68,70} lower perceived susceptibility to nicotine addiction,^{53,56,66,70} and e-cigarettes are used as a smoking-cessation tool.⁷⁰

Bernat and colleagues⁵³ reported that the proportion of adolescents who believed e-cigarettes would be easy to quit if they chose to, ranged from 16% among non-e-cigarette users to 55% among e-cigarette users. A qualitative study of e-cigarette users also reported they could easily quit if they decided to, and did not think they would become addicted to e-cigarettes.⁵⁰ Similarly, in the U.S. Population Assessment of Tobacco and Health study, 4% of adolescents who never smoked and had seen or heard of e-cigarettes but never used them perceived e-cigarettes as being *very unlikely* to be addictive.⁶⁶ Another qualitative study (U.S.) of mostly non-smokers reported e-cigarettes were less addictive than cigarettes because of the small amount of nicotine in them.⁵⁶ For example, a female 17-year-old stated, “I’m thinking that they probably don’t have as much nicotine or whatever is in cigarettes that make[s] them so addictive.”⁵⁶

One quantitative study⁵³ found that almost one third (31%) of adolescents reported that using e-cigarettes helped relieve stress, and e-cigarette users (ever user, past 30-day user, lifetime user) reported this more than adolescents who never used e-cigarettes.

Five studies (20%; 2 quantitative,^{16,72} 4 qualitative^{50,68,70,73}) reported that adolescents considered the flavors and vapor to be appealing. One quantitative study reported that cherry and candy flavors were perceived as less harmful than tobacco flavored e-cigarettes.⁷² Experimentation with

and use of e-cigarettes was considered a fun social activity with friends where flavors and smoke tricks could be trialed and discussed.^{53,68,70,73}

Sources of e-cigarette information and exposure. Seven studies discussed sources of e-cigarette information and exposure (1 quantitative,⁷² 6 qualitative^{50,56,68,70,71,73}). Of these studies, 3 qualitative studies (43%) reported adolescents' were exposed to e-cigarettes via peers, friends, and family.^{50,56,70} Authors also reported exposure to e-cigarette marketing and promotion via posters, billboards, TV, print, radio, retail point of sale,^{56,68,72,73} and online advertising.^{56,70} Other sources of e-cigarette information and exposure included Facebook, Twitter, YouTube, the Internet,^{70,72} national agencies and healthcare providers,^{56,71} and adolescents' direct experience with e-cigarettes.^{68,71}

DISCUSSION

This is the first systematic review that the authors are aware of to examine the health perceptions of e-cigarettes among adolescents aged 12–17 years living in the U.S., UK, Canada, Australia, and NZ. It is evident from the reviewed studies that there is a mix of perceptions held by this population about e-cigarettes. In general, regardless of cigarette or e-cigarette user status, adolescents regarded e-cigarettes to be a healthier alternative to cigarettes owing to the perception that nicotine in e-cigarettes is less addictive,^{50,56} there are minimal chemicals in e-cigarettes,⁶⁸ and secondhand vapor is safer for bystanders.^{55,62,68,70} Adolescents in 10 studies also perceived no adverse health impacts from using e-cigarettes.^{50,53,58–60,62,63,65,71,73} However, 10 studies also reported that adolescents believed there were adverse health impacts and were cautious about e-cigarettes based on the lack of evidence regarding their safety, secondhand vapor, and addiction potential.^{53,55,56,63,67,68,70–73}

This mixed perception of harm from e-cigarettes may stem from the lack of clear evidence surrounding their health impacts and lack of consensus within public health, along with misinformation surrounding e-cigarette safety, and e-cigarette advertising. For example, e-cigarettes are often promoted as a benign, efficacious smoking-cessation product,^{74,75} a position dramatically contrasting that of the U.S. Office of the Surgeon General, who has stated that any e-cigarette use among young people is unsafe.⁸

Dual users of cigarettes and e-cigarettes, cigarette-only users, and users of e-cigarettes only were more likely to consider e-cigarettes less harmful than cigarettes.^{51-53,62,64} This decreased harm perception increases the likelihood of e-cigarettes being perceived as attractive, and reconciles any cognitive dissonance regarding their use.⁷⁶ E-cigarettes were also perceived to be a stress-reducing agent,⁵³ and the array of flavors were reported to make the product appealing and appear less harmful and more fun,^{50,68,70,72,73} perhaps providing a rationale for adolescents to initiate vaping. Further insights are required for public health to respond and counter these perceptions.

Only 1 qualitative study explicitly discussed why adolescents perceived e-cigarettes as less harmful than cigarettes (e.g., e-cigarette vapor is evaporated water, “like a flavoured smoke,” and contains fewer toxins such as tar).⁶⁸ Adolescents who perceived this decreased relative harm of e-cigarettes may have been influenced by e-cigarette marketing and promotion (point of sale, TV, radio, and online), lack of regulation and health warning labels on packaging, and social networks.^{56,62,69-71,72} Previous research supports this notion, stating that adolescents perceive e-cigarettes to be less harmful than cigarettes because of marketing and lack of regulation.⁷⁷ Other sources of information and exposure, which may influence adolescents perception of e-cigarettes, varied and included experiences of/with peers, friends, family^{50,56,62,69,70}; direct

experience with the product⁶⁸; and the online environment.^{52,56,70,72} Youth spend a large proportion of their day (70%) on the Internet and social media,^{78,79} an environment where e-cigarette marketing and interactions have been increasing, particularly in the U.S.⁸⁰ as multinational tobacco companies investment increases.² In addition, adolescents' decreasing harm perception may be further reinforced by seemingly harmless e-juice flavors (e.g., "candy" and "fruit").¹⁶ Beyond this, the potential influence of various countries regulatory environment on adolescents' perceptions of e-cigarettes should also be acknowledged, as research suggests that the regulatory framework (less versus more restrictive) adopted by countries can affect perception of harm.⁸¹

This systematic review provides evidence that adolescents perceive e-cigarettes to be healthier than cigarettes,^{56,62,64,68} particularly among those who are current e-cigarette or cigarette users. This perception exists, despite inconclusive evidence on the health impact of e-cigarettes.^{82,83} Additionally, the potential for e-cigarettes to renormalize smoking and act as a gateway for youth smoking cannot be ignored⁸⁴ as there is evidence it can lead to the uptake of cigarettes.⁸⁵ This is concerning as the exponential growth in e-cigarette use may undermine the progress made in tobacco control over the last 50 years.

Strengths and Limitations

All the identified studies were conducted in the U.S., UK, and Canada, with no Australian or NZ studies identified, limiting understanding of adolescents' health perceptions of e-cigarettes across all investigated countries. Further research, particularly in Australia and NZ, is required to understand adolescents' health perceptions of e-cigarettes. Additionally, only 7 studies^{50,56,68-72} provided information on sources of e-cigarette information and exposure. Future studies should incorporate questions about sources of information. Furthermore, several studies used the same

data sets,^{51,52,54,58–61,63,70,71} limiting understanding of adolescents' perspectives. However, this is a new and emerging health area and therefore research is limited. A strength of this review is that it incorporated findings from both quantitative and qualitative studies.

CONCLUSIONS

Adolescents are aware of e-cigarette products and generally acknowledge them as being less harmful than cigarettes. Adolescents had mixed views on the potential health impacts of e-cigarette use. Some adolescents believed they had adverse health impacts, some believed they had no impacts, and others were unsure. However, e-cigarette and cigarette users and ever users tended to have a more favorable view of the product. More research is required, particularly in Australia and NZ, to better understand adolescents' health perceptions of e-cigarettes and where they source information so that misperceptions can be addressed through appropriate channels with suitable messaging.

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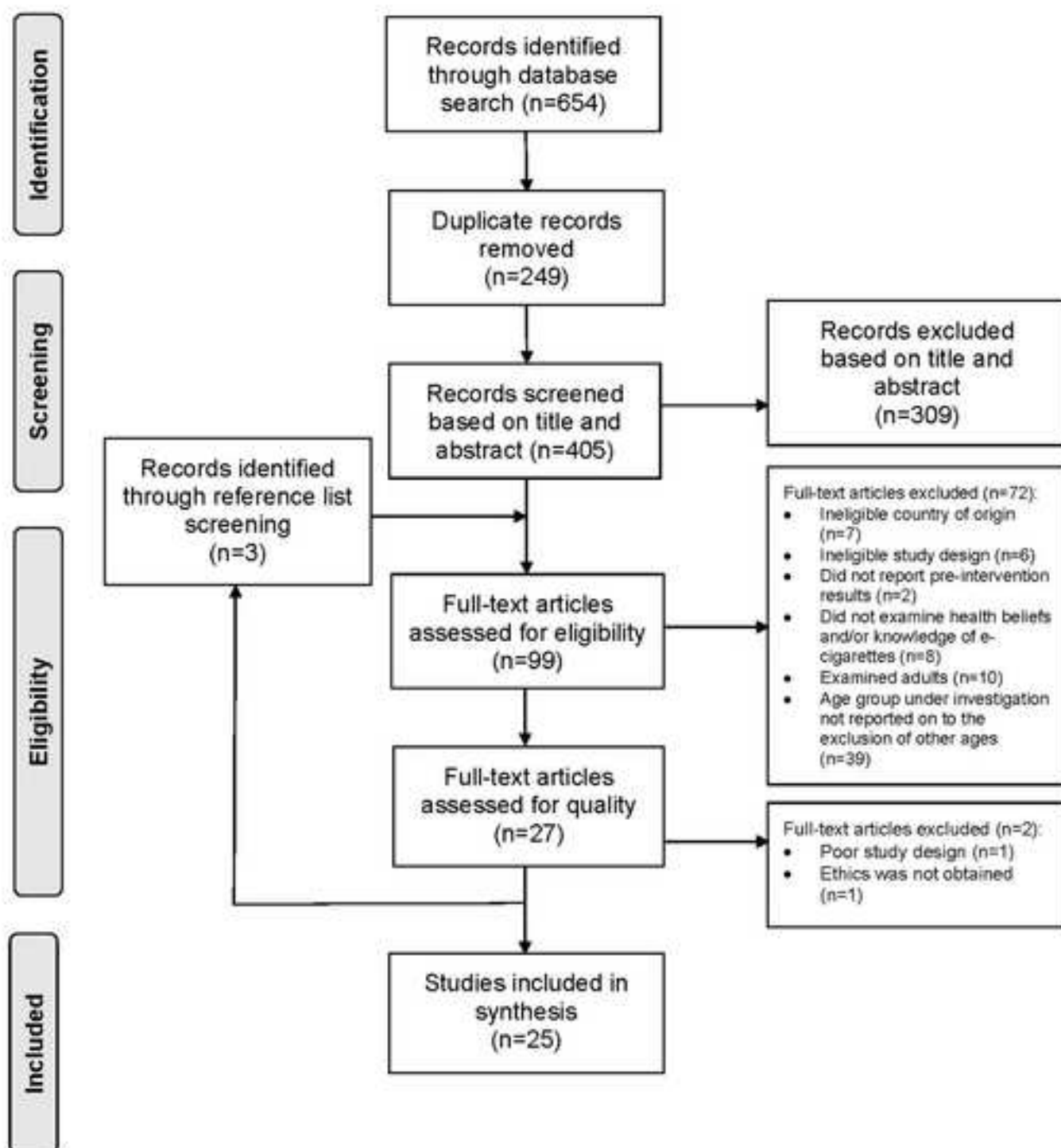
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LIST OF FIGURES

Figure 1. PRISMA flow diagram.



Appendix
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Appendix Table 1. Study Characteristics

Study ID	Data collection	Participant characteristics	Sample size	Results
Country	Study design and methods		Response rate (RR)	
Aim			Limitations	
Ambrose et al. (2014) ⁵¹ U.S.	Data collection: 2012 <ul style="list-style-type: none"> • Cross-sectional • Stratified 3-stage cluster sampling • Self-administered paper-based survey (National Youth Tobacco Survey [NYTS] 2012) 	Age: 6–12th grade <ul style="list-style-type: none"> • 6–8th grade 43.9% (excluded from analysis) • 9–10th grade 29.8% • 11–12th grade 26.3% (excluded from analysis) Sex <ul style="list-style-type: none"> • Female 48.9% • Male 51.1% Ethnicity <ul style="list-style-type: none"> • White, non-Hispanic 53.9% • Black, non-Hispanic 13.9% • Hispanic 21.7% • Other, non-Hispanic 10.6% User status <ul style="list-style-type: none"> • Committed never smoker 53.2% • Susceptible never smoker 17.5% • Very susceptible never smoker 2.9% • Ever but not current smoker 16.9% 	Private, parochial, and public schools in the 50 states and District of Columbia n=24,658 students RR: Schools 80% (228/284), students 74% Limitations <ul style="list-style-type: none"> • Small proportion of non-responses • Self-report • Findings may not be generalizable to those outside of sampling frame 	<ul style="list-style-type: none"> • 50.8% had not heard of ECs or did not know enough about ECs to judge if they were more, less or equally harmful as cigarettes (this includes grades 6 to 12). • 36.9% current smokers in grades 9–10 consider ECs to be less harmful than cigarettes. • 34.7% of ever but not current smokers in grades 9–10 consider ECs to be less harmful than cigarettes. • 27.9% of never smokers in grades 9–10 consider ECs to be less harmful than cigarettes. • Regardless of smoking status, ever EC use was strongly associated with perceiving ECs as less harmful than cigarettes (includes all grades). • Current smoker: 2.48 adjusted odds ratio (95% CI: 1.87, 3.29) <ul style="list-style-type: none"> ○ Ever but not current smoker: 2.57 adjusted odds ratio (95% CI: 1.91, 3.46) ○ Never smokers: 5.88 (95% CI: 3.07, 11.25) • On a continuum ECs were perceived as less harmful than cigarettes (includes all grades).

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		<ul style="list-style-type: none"> • Current smoker 9.4% • Ever used an e-cigarette 6.8% • Current dual use (Cigarette +EC) 1.6% 		
<p>Amrock et al. (2015)⁵² U.S.</p> <p>Examine the association between adolescent awareness and use of ECs, perceived danger compared to cigarettes, and correlates of EC use among cigarette- naïve (never smoke) adolescents.</p>	<p>Data collection: 2012</p> <ul style="list-style-type: none"> • Cross-sectional • Stratified multi-stage cluster sampling • Self-administered paper-based survey NYTS 2012 	<p>Age: ≤12 to ≥17 years</p> <ul style="list-style-type: none"> • ≤12 19.8% (excluded from analysis) • 13 14.6% • 14 14.2% • 15 14.7% • 16 14.5% • ≥17 22.3% (excluded from analysis) <p>Sex</p> <ul style="list-style-type: none"> • Female 51.1% • Male 48.8% <p>Ethnicity</p> <ul style="list-style-type: none"> • White, non-Hispanic 53.9% • Black, non-Hispanic 13.9% • Hispanic 21.7% • Asian, non-Hispanic 3.7% • Other/multiple 6.9% <p>User status</p> <ul style="list-style-type: none"> • EC users • Cigarettes users • Users of EC and cigarettes • Not aware of ECs 	<p>Public, secular, or non-secular private schools in the U.S. n=24,644</p> <p>RR: Schools 80.3%, students 91.7%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Data are cross-sectional and cannot be used to infer causality • Self-report • Socioeconomic influences not accounted for 	<ul style="list-style-type: none"> • Of those who had heard of ECs, 45.3% of 13 year olds, 44.8% of 14 year olds, 43.6% of 15 year olds, 42% of 16 year olds did not know how harmful ECs were compared to cigarettes. (Mean=43.9%) • 34.6% of 13 year olds, 35.3% of 14 year olds, 34.9 % of 15 year olds, and 36.1% of 16 year olds believed ECs were less harmful than cigarettes. Adolescents who reported this were more likely to use ECs and report them as less dangerous. (Mean=35.2%) • 3.2% of 13 year olds, 3.3% of 14 year olds, 3.7% of 15 year olds, and 2.6% of 16 year olds reported ECs to be more harmful than cigarettes. (Mean=3.2%) • 71.8% of those who ever used ECs believed them to be less harmful than cigarettes • 73.8% of those who were current EC users believed them to be less harmful than cigarettes • EC harm was positively associated with EC use, including among naïve EC users

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<p>East et al. (2018)⁶⁹ UK</p> <p>Assess the prevalence and correlates between accurately perceiving ECs as less harmful than cigarettes. Assess that none or a small amount of smoking harm comes from nicotine.</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Cross-sectional • Stratified sampling • Self-administered online national survey via email invitation 	<p>Age: 11 to 18 years</p> <ul style="list-style-type: none"> • 11–13 35.2% (n=698) (excluded from analysis) • 14–15 25.6% (n=487) • 16–18 39.2% (n=918) (excluded from analysis) <p>Sex</p> <ul style="list-style-type: none"> • Female 48.5% • Male 51.5% <p>User status</p> <ul style="list-style-type: none"> • Examined by EC and cigarette users • EC: Tried or used sometimes, at least monthly • Cigarette: Tried, ex-smoker, sometimes, at least weekly 	<p>Great Britain n=2,331</p> <p>RR: not reported</p> <p>Limitations</p> <ul style="list-style-type: none"> • Cross-sectional and cannot be used to infer causality • Findings may not be generalizable to those outside of sampling frame and over time • Rates of regular smoking and regular EC use were low, which findings may result in low power when drawing comparisons between these behaviors and harm perceptions 	<ul style="list-style-type: none"> • 62.0% of 14-15 year old age group reported ECs were less harmful than cigarettes. • 63% had an accurate harm perceptions of ECs relative to cigarettes. (includes all age groups) • Accurate relative harm perceptions of ECs were higher among those who were older, had tried or used an EC, had at least 1 family member who used ECs, had no friends who smoke (includes all age groups). • 7.62% of 14–15 year olds accurately perceived nicotine causes little or no health harms from nicotine. • 9% accurately perceived that nicotine causes little or no health harms from nicotine (includes all age groups). <p><i>*Note: accurate harm perception was when participants perceived ECs as less harmful.</i></p>
<p>Ford et al. (2016)⁷² UK</p> <p>Examine adolescents' awareness of EC marketing & investigate impact of EC flavor descriptors on perceptions of</p>	<p>Data collection: 2014</p> <ul style="list-style-type: none"> • Cross-sectional • Random location quota sampling • In-home face-to-face interview followed by self-completion questionnaire • Youth Tobacco Policy Survey 	<p>Age: 11 to 16 years</p> <ul style="list-style-type: none"> • 11 19.9% (excluded from analysis) • 12 15.1% • 13 16.8% • 14 18.2% • 15 15.7% • 16 14.3% <p>Sex</p> <ul style="list-style-type: none"> • Female 50.1% • Male 49.9% <p>User status</p>	<p>Households in UK n=1,205</p> <p>RR: Not reported</p> <p>Limitations</p> <ul style="list-style-type: none"> • Data are cross-sectional and cannot be used to infer causality • Does not cover all types of EC promotions • Findings may not apply to other flavors in the same category 	<ul style="list-style-type: none"> • ECs perceived as harmful (m=3.54, SD=1.19) (5-point semantic scale ranging from 'Not at all harmful to health [1] to 'Very harmful to health' [5]). • When compared to generic ECs, tobacco flavored ECs were perceived as more harmful than cherry and candy flavored ECs: • Candy floss (m=3.02, SD=1.35, $p<0.001$) • Cherry (m=3.08, SD=1.29, $p<0.001$) • Coffee (m=3.48, SD=1.44, $p=0.234$) • Tobacco (m=3.99, SD=1.14, $p<0.001$) <p>Sources of EC information/exposure.</p> <ul style="list-style-type: none"> • EC shop displays 73%

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product harm & user image.		<ul style="list-style-type: none"> Not sampled for smoking status described and analyzed by status in results; EC use described by status in results Ever smokers 18.8% Never smokers 78.7% 		<ul style="list-style-type: none"> Television adverts 40% Posters and billboards 32% Social media 29% Radio 10%
Kwon et al. (2018)⁶⁶ U.S. Investigate factors affecting youth susceptibility to EC use.	Data collection: 2013–2014 <ul style="list-style-type: none"> Cross sectional Stratified 4-stage probability sampling Audio computer assisted self-interviews U.S. PATH study 	Age: 12 to 17 years <ul style="list-style-type: none"> 12–14 54.6% 15–17 45.4% Sex <ul style="list-style-type: none"> Female 51.0% Male 49.0% Ethnicity <ul style="list-style-type: none"> Non-Hispanic White 49.5% Hispanic White 20.2% Hispanic Black 1.6% Non-Hispanic Black 13.9% Other 14.7% User status <ul style="list-style-type: none"> Never smoked cigarette and had seen or heard of ECs but never used them 	Non-institutionalized U.S. residents n=9,853 RR: 78.4% youth interview Limitations <ul style="list-style-type: none"> Self-reported, therefore findings are subject to recall bias Data are cross-sectional and therefore cannot infer causality 	Perceived addictiveness <ul style="list-style-type: none"> 45.4% perceived ECs as somewhat likely addictive. 20.1% perceived ECs as very likely addictive. 15.6% perceived ECs are neither likely to be addictive or not addictive. 8.5% perceived ECs as somewhat unlikely addictive. 4.1% perceived ECs as very unlikely addictive. Relative harmfulness <ul style="list-style-type: none"> 45.7% said ECs as less harmful than cigarettes. 40.2% said ECs as just as harmful as cigarettes. 4.9% said ECs as more harmful than cigarettes.
Parker et al. (2018)⁵⁸ U.S. Examine	Data collection: 2013/2015 <ul style="list-style-type: none"> Longitudinal prospective cohort 	Age: 12 to 17 years <ul style="list-style-type: none"> 12–14 61.4% 15–17 38.6% Sex <ul style="list-style-type: none"> Female 48.5% 	Non-institutionalized civilian population n=10,081 RR: not reported Limitations	Discusses measuring relative and absolute harm. <ul style="list-style-type: none"> 51.1% reported ECs were less harmful than cigarettes. 43.8% reported that harm from ECs was about the same as cigarettes.

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relationships between product harm perceptions & new use of multiple tobacco products.	<ul style="list-style-type: none"> Address-based, area-probability sampling Audio computer-assisted interviews U.S. PATH study 	<ul style="list-style-type: none"> Male 51.5% <p>Ethnicity</p> <ul style="list-style-type: none"> White, non-Hispanic 54.6% African American, non-Hispanic 13.6% Other, non-Hispanic 9.2% Hispanic 22.5% <p>User status Cigarettes, e-cigarettes, cigars, pipes, hookah, smokeless tobacco</p>	<ul style="list-style-type: none"> Self-report 	<ul style="list-style-type: none"> 5.1% reported ECs were more harmful than cigarettes. 26.6% reported ECs caused a lot of absolute harm (v cigarettes 84.8%) 43.8% reported ECs caused some absolute harm 29.6% reported ECs caused no or little absolute harm Relative and absolute perceived harm was lowest for ECs compared with other tobacco products. Youth who believe e-cigarettes pose little or no harm were more than twice as likely to try them compared to youth who believe the products pose a lot of harm.
<p>Persoskie et al. (2017)⁶¹ U.S.</p> <p>Examine the validity of direct and indirect measure of perceived harm of ECs & smokeless tobacco compared to cigarettes.</p>	<p>Data collection: 2013/2014</p> <ul style="list-style-type: none"> Longitudinal cohort Address-based area-probability sampling Audio computer-assisted interviews U.S. PATH study 	<p>Age: 12 to 17 years</p> <ul style="list-style-type: none"> 12–13 48.7% 14–15 33.3% 16–17 33.0% <p>Sex</p> <ul style="list-style-type: none"> Female 48.7% Male 51.3% <p>User status</p> <ul style="list-style-type: none"> Not sampled but most not current users of cigarettes, ECs or smokeless tobacco (>95%), not analyzed 	<p>U.S. non-institutionalized population n=13,651</p> <p>RR: Youth 78.4%</p> <p>Limitations</p> <ul style="list-style-type: none"> Responses should be regarded within the context they were collected 	<ul style="list-style-type: none"> 67.3% indirectly reported ECs were less harmful than cigarettes (95% CI: 66.2, 68.3%). 29.2%, indirectly reported ECs had about the same harm as cigarettes (95% CI: 28.1, 30.2%) Direct measures of perceived harm (comparison to cigarettes) 50.2% ECs less harmful than cigarettes (95% CI: 49.2, 51.3%) 37.8% ECs about the same harm (95% CI: 36.8, 38.8%) <p><i>*Note Direct measure-people compare one product to another [e.g., is using ECs less harmful, about the same, or more harmful than smoking cigarettes?]. Indirect measure- people rate each product separately [e.g., how much do you think people harm themselves when they use ECs?].</i></p>
<p>Strong et al. (2019)⁶³</p>	<p>Data collection: 2013/2014</p>	<p>Age: 12 to 17 years</p> <ul style="list-style-type: none"> 12–13 34% 	<p>U.S. non-institutionalized population</p>	<ul style="list-style-type: none"> Overall mean harm perception score for ECs was 1.95 indicating less harmful than cigarettes

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<p>U.S. Describe youth harm perceptions & addictiveness of tobacco products. Understand patterns among non-users & tobacco users from the PATH Study. Examine if tobacco product harm perceptions varied among non-users.</p>	<ul style="list-style-type: none"> • Longitudinal cohort • Stratified address-based, area-probability sampling • Audio-computer assisted self-interviews • U.S. PATH study 	<ul style="list-style-type: none"> • 14–15 50% • 16–17 16% <p>Sex</p> <ul style="list-style-type: none"> • Female 49% • Male 51% <p>Ethnicity</p> <ul style="list-style-type: none"> • Non-Hispanic white 48% • Hispanic 29% • Black 14% • Other non-Hispanic 9% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for but results include breakdown by users of different tobacco products including ECs 	<p>n=13,651 RR: 78%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Data are cross-sectional and cannot be used to infer causality • Limited by the number and types of questions asked 	<p>across all age categories. (using scale ‘1=Less harmful’, ‘2=About the same’, ‘3=More harmful’).</p> <ul style="list-style-type: none"> • Perceived harmfulness of ECs separated by age and sex: 12–13=2.01; 14–15=1.92; 16–17=1.93 Males=1.89; females=2.01 (Using the scale ‘1=No harm or little harm’, ‘2=Some harm’, ‘3=A lot of harm’). • Adolescents mean score for addictiveness of ECs for somewhat likely was $m=3.6$. Separate mean results for age and sex: Ages 12–13=3.75; 14–15=3.56; 16–17=3.47. Males=3.51; females=3.71 (Using the scale ‘1=Very unlikely’, ‘2=Somewhat unlikely’, ‘3=Neither likely nor unlikely’, ‘4=Somewhat likely’, and ‘5=Very likely’). • The mean addictiveness rating was lower for ECs than other tobacco products including cigarettes. • Incrementally lower levels of harm and addictiveness perceptions were observed among youth at increasing risk of tobacco use ($p's < 0.05$).
<p>Bernat et al. (2018)⁵³ U.S. Examine adolescent perceptions of harms & benefits associated with ECs, &</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Cross-sectional • 2-stage cluster probability sampling • Self-administered paper-based survey • Florida Youth Tobacco Survey 	<p>Age: 14 to 17 years</p> <ul style="list-style-type: none"> • 14 13.4% • 15 29.8% • 16 30.3% • 17 26.5% <p>Sex</p> <ul style="list-style-type: none"> • Female 48.8% • Male 51.2% <p>Ethnicity</p> <ul style="list-style-type: none"> • Non-Hispanic white 42.0% 	<p>Florida State public middle and high schools n=22,884 RR: 96% schools, 74% students</p> <p>Limitations</p> <ul style="list-style-type: none"> • Data are cross-sectional and cannot be used to infer causality • Did not assess whether participants used e- 	<ul style="list-style-type: none"> • 43.2% reported that ECs were harmful to health. • 21.1% reported that ECs were not harmful to health. • 35.8% reported they were unsure if ECs were harmful to health. • 47.2% reported second-hand smoke from ECs was harmful to health. • 26.2% reported ECs were easy to quit. • 43.1% believed ECs were less harmful than cigarettes. • 18.9% equally harmful

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<p>associations with use.</p>	<ul style="list-style-type: none"> • Non-Hispanic black 21.8% • Non-Hispanic Asian 2.3% • Hispanic 30.4% • Other 3.5% <p>User status</p> <ul style="list-style-type: none"> • Excluded those who used other tobacco products • User groups: committed e-cig user, susceptible never user, lifetime users, past 30 day users 	<p>liquids with or without nicotine</p> <ul style="list-style-type: none"> • Findings may not be generalizable to those outside of sampling frame 	<ul style="list-style-type: none"> • 5.3% more harmful • 32.7% not sure • 61.5% reported ECs were addictive • 22.4% reported ECs were not addictive • 16.1% were unsure if ECs were addictive • All EC user groups had lower odds of reporting ECs were harmful to health (AORs=0.14–0.38) than never users. • All EC user groups had lower odds of reporting that people can get addicted to ECs (AORs=0.49–0.67) than never users. • All EC user groups had lower odds of reporting that smoke from ECs was more harmful (AORs=0.12–0.32) than never users. • All EC user groups had higher odds of reporting that ECs were a stress relief (AORs=1.79–5.78) than never users. • Benefits • 13.8% believed they would have more friends • 10.3% believed ECs make you look cool • 28.2% felt comfortable at social events • 31.4% reported ECs helped relieve stress 	
<p>Chaffee & Cheng (2018)⁵⁴ U.S.</p> <p>Examine how initiation with 1 tobacco type was associated with cross-product susceptibility</p>	<p>Data collection: 2013–2015</p> <ul style="list-style-type: none"> • Longitudinal cohort – wave one • Stratified 4-stage address-based area-probability sampling • In-home, in-person computer-assisted interviews 	<p>Age: 12 to 16 years</p> <ul style="list-style-type: none"> • 12–14 65.2% • 15–17 34.8% <p>Sex</p> <ul style="list-style-type: none"> • Female 49.6% • Male 50.4% <p>Ethnicity</p> <ul style="list-style-type: none"> • Hispanic/Latino 22.4% • Non-Hispanic Black 14.1% 	<p>Non institutionalized civilian population n=8,005</p> <p>RR: Youth 78.4%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Self-report • Residual confounding cannot be ruled out • Analytic sample that was smaller in number and younger than the overall Population 	<ul style="list-style-type: none"> • 37.6% reported new initiation of ECs decreased perceived harm of ECs • 19.8% reported new initiation of ECs did not decrease perceived harm of ECs • New use of cigarettes had higher odds to decrease perceived harm of ECs (OR 1.11; 95% CI: 0.69, 1.77) • New use of ECs had higher odds to decrease perceived harm of ECs (OR 2.90; 95% CI: 2.12, 3.97)

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<p>changes and perceived harm of all tobacco types & nicotine products.</p>		<ul style="list-style-type: none"> • Non-Hispanic White 54.1% • Other/missing 9.4% <p>User status</p> <ul style="list-style-type: none"> • Tracked uptake of various tobacco products, analyzed by status 	<p>Assessment and Health (PATH) study cohort</p>	
<p>Farrelly et al. (2015)⁵⁵ U.S.</p> <p>To determine if exposure to EC television advertisements influences intentions to use ECs in the future & related attitudes.</p>	<p>Data collection: 2014</p> <ul style="list-style-type: none"> • Parallel-group randomized control trial • Convenience sampling • Self-administered online survey 	<p>Age: 13 to 17 years</p> <ul style="list-style-type: none"> • 13 17.1% • 14 18.7% • 15 21.2% • 16 21.8% • 17 21.2% <p>Sex</p> <ul style="list-style-type: none"> • Female 49.9% • Male 50.2% <p>Ethnicity</p> <ul style="list-style-type: none"> • White, non-Hispanic 70.1% • Black, non-Hispanic 8.9% • Asian, non-Hispanic 4.6% • Hispanic 10.2% • Other, non-Hispanic 6.2% • Missing information 0.1% <p>User status</p> <ul style="list-style-type: none"> • Never tried ECs 	<p>U.S. n=3,655</p> <ul style="list-style-type: none"> • n (control)=2,490 • n (intervention)= 2,495 <p>RR: not reported</p> <p>Limitations</p> <ul style="list-style-type: none"> • May not be generalizable to those outside of sampling frame • Absence of a behavioral outcome • Forced exposure to advertising design 	<p>Data from the control group who had never tried ECs and not exposed to television advertising reported below. For analysis, authors dichotomized responses as 'agree or strongly agree' compared to strongly disagree or disagree, neither agree nor disagree, or I don't know'.</p> <ul style="list-style-type: none"> • 47.6% reported ECs as harmful or very harmful. • 39.2% reported they were a safer than cigarettes. • 37.0% reported they were less toxic than cigarettes. • 31.4% reported people can use ECs without affecting those around them (safe exposure to secondhand vapor).
<p>Giovacchini et al. (2017)⁶⁵</p>	<p>Data collection: 2015</p>	<p>Age: 11 to 18 years</p>	<p>4 middle schools, 3 high schools, Orange County,</p>	<ul style="list-style-type: none"> • Risk perception of EC use decreased as grade levels increased ($p<0.001$)

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<p>U.S.</p> <p>Describe lifetime use & perceived risk of EC use in the context of other risk-taking behaviors among adolescents.</p>	<ul style="list-style-type: none"> • Cross-sectional • Cluster sampling • Self-administered paper-based survey • North Carolina Youth Risk Behavior Survey 	<ul style="list-style-type: none"> • 6th graders 33.0% (excluded from analysis) • 7th graders 42.5% • 8th graders 24.5% • 9th graders 30.2% • 10th graders 23.4% • 11th graders 20.6% • 12th graders 25.8% (excluded from analysis) <p>Sex</p> <ul style="list-style-type: none"> • Female 47.2% • Male 52.6% <p>Ethnicity</p> <ul style="list-style-type: none"> • White 59.8% • African American 10.9% • Asian 24.8% • Hispanic 10.9% • Other 4.5% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for but cigarette, EC, alcohol, and substance use status described and analyzed in results 	<p>North Carolina n=935</p> <p>RR: 99%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Self-reporting • Analysis of data from a single school district, limits generalizability of findings 	<ul style="list-style-type: none"> • Perceived risk of harming themselves using EC use reported as “great risk”: • 7th graders 31.5% • 8th graders 32.2% • 9th graders 13.0% • 10th graders 12.9% • 11th graders 13.3%
<p>Padon et al. (2018)⁵⁷</p> <p>U.S.</p> <p>Explore the exposure effect</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Randomized control trial • Self-administered online survey 	<p>Age: 13 to 17 years</p> <ul style="list-style-type: none"> • 13 13.1% • 14 17.8% • 15 21.4% • 16 20.7% • 17 26.9% 	<p>U.S. n=417</p> <ul style="list-style-type: none"> • n (control)=145 • n (intervention)=272 <p>RR: not reported</p> <p>Limitations</p>	<p>Data from the control group who had never tried ECs and not exposed to television advertising are only reported.</p> <ul style="list-style-type: none"> • 8% agreed that ECs are healthy. • 25% in the low youth appeal condition agreed ECs are healthy.

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<p>of different EC advertisements on youth EC and tobacco cigarette-related beliefs & intentions using both explicit & implicit measures of attitudes and susceptibility toward trying tobacco and EC products.</p>	<p>Sex</p> <ul style="list-style-type: none"> • Female 59.0% • Male: 41.1% <p>Ethnicity</p> <ul style="list-style-type: none"> • White, non-Hispanic 52.4% • Black, non-Hispanic 11.7% • Hispanic 19.3% • Other, non-Hispanic 16.6% <p>User status</p> <ul style="list-style-type: none"> • Aware of ECs but non-smokers 	<ul style="list-style-type: none"> • Potential non-response bias • Post-randomization dropout 	<ul style="list-style-type: none"> • 13% in the high youth appeal condition agreed ECs are healthy. 	
<p>Pepper et al. (2016)¹⁶ U.S.</p> <p>Explore if perceived harm of ECs was affected by the relationship between flavors & interest in use, & whether this relationship changed depending on flavors.</p>	<p>Data collection: 2014/2015</p> <ul style="list-style-type: none"> • Cross-sectional • Probability sampling • Phone survey 	<p>Age: 13 to 17 years</p> <p>Sex</p> <ul style="list-style-type: none"> • Female 50.1% • Male 49.9% <p>Ethnicity</p> <ul style="list-style-type: none"> • Non-Hispanic White 76.4% • Non-Hispanic other race 16.2% • Hispanic 7.5% <p>User status</p> <ul style="list-style-type: none"> • Not sampled but most never used or tried cigarettes or ECs (90% and 85%), not analyzed 	<p>U.S., further sample population information not stated n=1,125</p> <p>RR: Youth 66%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Low response rate 	<ul style="list-style-type: none"> • Adolescents perceived fruit-flavored e-cigarettes to be less harmful than tobacco flavored (mean 2.71 vs 2.87, $\beta = -0.08$, $p < 0.05$), but they did not view the other flavors as more harmful (alcohol=3.00, menthol=2.87 and candy=2.78). (Likert scale 1= 'not at all to 4= 'extremely'. • Greater perceived harmfulness was associated with less interest in trying ECs (OR=0.31, 95% CI=0.22, 0.43). • 3.6% reported ECs did not contain nicotine; 14.6% or did not know if they contained nicotine.

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<p>Pepper et al. (2018)⁵⁹ U.S.</p> <p>Explore adolescents use of nicotine free ECs & understanding of the chemicals in ECs.</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Cross sectional • Convenience sampling • Self-administered online survey 	<p>Age: 15 to 17 years</p> <ul style="list-style-type: none"> • 15–16 63.8% • 17 36.2% <p>Sex</p> <ul style="list-style-type: none"> • Female 48.2% • Male 51.8% <p>Ethnicity</p> <ul style="list-style-type: none"> • Non-Hispanic White 56.9% • Non-Hispanic Black 6.9% • Non-Hispanic other/multiple races 22.1% • Hispanic 14% <p>User status</p> <ul style="list-style-type: none"> • EC users 	<p>U.S. adolescents on Facebook and Instagram n=925</p> <p>RR: not reported</p> <p>Limitations</p> <ul style="list-style-type: none"> • Not reported 	<ul style="list-style-type: none"> • Usual ECs users with nicotine reported the perceived likelihood of developing health problems in adulthood (2.38 to 2.53) was unlikely. (Likert scale 1= “not at all likely” to 5= “extremely likely”)
<p>Pepper et al. (2019)⁶⁰ U.S.</p> <p>Determine the most frequently used vaping device types in the country & examine the correlates and potential risk factors for using intermediate & advanced devices relative</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Cross-sectional • Convenience sampling • Self-administered online survey 	<p>Age: 15 to 17 years</p> <ul style="list-style-type: none"> • 15 13.9% • 16 37.3% • 17 48.8% <p>Sex</p> <ul style="list-style-type: none"> • Female 57.4% • Male 42.6% <p>Ethnicity</p> <ul style="list-style-type: none"> • White, non-Hispanic 64.5% • Black, non-Hispanic 6.1% • Hispanic 15.1% • Other or multiracial, non-Hispanic 14.3% <p>User status</p>	<p>U.S. adolescents on Facebook and Instagram n=1,508</p> <p>RR: not reported</p> <p>Limitations</p> <ul style="list-style-type: none"> • Findings may not be generalizable to those outside of sampling frame 	<ul style="list-style-type: none"> • Health problems from using ECs in a basic, intermediate, and advanced device user was reported as unlikely ($m=2.5$, $SD=1.1$). (Using a 5-point Likert scale ranging from 1= ‘not all likely’ to 5= ‘extremely likely’). • Reported harm of vaping in basic device user: ($m=2.8$, $SD=1.2$). • Reported harm of vaping in intermediate device user: ($m=2.4$, $SD=1.1$). • Reported harm of vaping in advanced device user: ($m=2.5$, $SD=1.1$). <p><i>*Note Advanced vaping devices likely pose a greater risk to adolescent health than basic or intermediate devices because they deliver nicotine more effectively and heat e-liquid to</i></p>

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to basic devices.		<ul style="list-style-type: none"> • EC users 		<i>higher temperatures, producing more harmful chemical emissions.</i>
<p>Roditis et al. (2016)⁶⁷ U.S.</p> <p>Assess perceptions of overall harm, short-term health and social risks, long-term health risks, & benefits associated with various tobacco products (cigarettes, ECs, cigars, chew, and hookah). Assess how perceptions differ by age, gender, race/ethnicity & previous experience with tobacco.</p>	<p>Data collection: Not reported</p> <ul style="list-style-type: none"> • Cross-sectional • Cluster sampling • Self-administered online survey 	<p>Age: 13 to 19 years</p> <ul style="list-style-type: none"> • Mean age=16.16 years, SD=1.6 • (16 to 19 yr olds excluded) <p>Sex</p> <ul style="list-style-type: none"> • Female 62.7% • Male 36.1% <p>Ethnicity</p> <ul style="list-style-type: none"> • White 27% • Asian/Pacific Islander 21.9% • Hispanic 29.7% • Other 21.4% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for but various tobacco product status described and analyzed in results 	<p>8 high schools in Northern and Southern California n=722</p> <p>RR: 55.6%</p> <p>Limitations</p> <ul style="list-style-type: none"> • Results may not be generalizable to those outside of sampling frame • Low response rate 	<ul style="list-style-type: none"> • 13–15-year-olds reported ECs would moderately harm their health ($m=3.61$, $SD=1.26$) (Using a 5-point Likert scale ranging from 1= ‘not at all’ to 5= ‘Extremely’). • 13–15-year-olds reported ECs would moderately harm the environment ($m=3.14$, $SD=1.38$). • 13–15-year-olds perceived short term health risks from EC use included bad cough (47.6%), cold (38.4%), trouble catching breath (51.8%), mouth sores (42.5%), and worse sports performance (53.9%). • 13–15-year-olds perceived long term health risks from EC use included oral cancer (57.3%), wrinkles (61.2%), heart attack (57.0%), lung cancer (61.4%), tobacco-related disease (61.9%), tobacco-related death (56.7%). • 13–15-year-olds thought that ECs had less short term and long-term health risks compared to other tobacco products.
<p>Wills et al. (2017)⁶⁴ U.S.</p>	<p>Data collection: 2013/2014</p>	<p>Age: 14 to 16 years</p> <ul style="list-style-type: none"> • 9th graders 49.0% • 10th graders 42.0% 	<p>4 public and 2 private high schools, Oahu, Hawaii</p>	<ul style="list-style-type: none"> • Dual users (OR=2.59], cigarette only smokers (OR=2.38), and EC users (OR=3.18) were more

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<p>Examine if EC use was related to the onset of smoking, longitudinal predictors for EC uptake, and if EC use was associated with smoking reduction among baseline smokers.</p>	<ul style="list-style-type: none"> • Longitudinal cohort • Convenience sampling • Self-administered paper-based survey 	<ul style="list-style-type: none"> • 11th graders 9.0% • Mean age=14.7 years, SD=0.7 <p>Sex</p> <ul style="list-style-type: none"> • Female 53.0% • Male 47.0% <p>Ethnicity</p> <ul style="list-style-type: none"> • Asian-American (Chinese, Japanese or Korean) 24.0% • Filipino-American 27.0% • Native Hawaiian or other Pacific Islander 20.0% • Caucasian 19.0% • Other race/ethnicity 10.0% 	<ul style="list-style-type: none"> • Time point 1 n=2,338 • Time point 2 n=2,239 <p>RR</p> <ul style="list-style-type: none"> • School 90% (6/7) • Student Time point 1 70% • Student Time point 2 67% <p>Limitations</p> <ul style="list-style-type: none"> • Attrition from baseline sample • Self-report 	<p>likely to report EC as healthier than cigarettes in comparison to non-users.</p> <ul style="list-style-type: none"> • Data for Time 1 indicated that 96% of participants were aware of ECs and 68% reported they were healthier than cigarettes. • (31% of the sample had ever used ECs at Time 1, and 38% at Time 2).
<p>Alexander et al. (2019)⁵⁰ U.S.</p> <p>Understand e-cigarette (EC) use & behavior in regular EC users.</p>	<p>Data collection: February 2016</p> <ul style="list-style-type: none"> • Grounded theory • Convenience sampling • Focus groups 	<p>Age: 14 to 17 years</p> <ul style="list-style-type: none"> • Grade 8 4.9% • Grade 9 19.5% • Grade 10 31.7% • Grade 11 24.4% • Grade 12 17.1% • Not in school 2.4% • Mean age=15.8, SD=1.1 <p>Sex</p> <ul style="list-style-type: none"> • Female 46.3% 	<p>Miami, Florida, and Raleigh, North Carolina n=41</p> <p>Limitations</p> <ul style="list-style-type: none"> • Small sample size • Convenience sample • Not nationally representative • Did not address dual use • Generate findings from 1 point in time and did 	<ul style="list-style-type: none"> • Reported there were no studies saying it was unsafe or harmful. • Thought a future study would find ECs unhealthy. • Were aware that ECs could contain nicotine. • Were unsure if the e-liquid they had used contained nicotine. • Reported they could tell if an e-liquid contained nicotine by the color (e.g., higher levels of nicotine made e-liquids darker) and the effects (e.g., higher levels of nicotine increased the

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		<ul style="list-style-type: none"> • Male 53.7% <p>Ethnicity</p> <ul style="list-style-type: none"> • Hispanic 29.3% • Non-Hispanic 70.7% <p>User status</p> <ul style="list-style-type: none"> • Regular EC users 	<p>not address the rapid and regular introduction of new device types (such as Juul)</p> <ul style="list-style-type: none"> • Findings may not be generalizable to those outside of sampling frame 	<p>likelihood of a strong taste made them feel lightheaded or “buzzed”).</p> <ul style="list-style-type: none"> • Flavors were the most popular reason for trying ECs • Stop use reasons (1) ECs are harmful to health; (2) not being with friends who use them; (3) ECs being replaced by a new product <p>Sources of EC information/exposure:</p> <ul style="list-style-type: none"> • From friends, older siblings, or other family members.
<p>de Andrade et al. (2016)⁶⁸ UK</p> <p>Thematically analyze 13–16 year olds responses & explore their perceptions of ECs.</p>	<p>Data collection: 2014</p> <ul style="list-style-type: none"> • Grounded theory • Purposive sampling • Data were generated through 3 co-produced classroom radio tasks with pupils (radio quiz, sitcom, factual interviewing) 	<p>Age: 13 to 16 years</p> <p>Sex</p> <ul style="list-style-type: none"> • Female 50.5% • Male: 49.5% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for or analyzed 	<p>Primary and secondary public schools in Fife, Scotland n=182</p> <p>RR: Schools 37% (7/19)</p> <p>Limitations</p> <ul style="list-style-type: none"> • Responses were respondent-led as opposed to researcher-led and less depth when compared to data captured in interviews • Responses to be regarded in method they were collected 	<ul style="list-style-type: none"> • ECs less harmful than cigarettes. • ECs safer than smoking because there is no tar or chemicals, they are ‘just like a flavored smoke’ and ‘evaporated water’. • Unsure of ECs health impact as they knew no one had tested EC ingredients. • Nicotine in ECs as addictive as cigarettes. • ECs ‘safer’, ‘less harmful’, ‘healthier, and ‘less toxic’ than cigarettes.
<p>Hammal and Finegan (2016)⁷³ Canada</p> <p>Qualitatively explore</p>	<p>Data collection: 2016</p> <ul style="list-style-type: none"> • Grounded theory • Convenience and stratified quota sampling strategies with 	<p>Age: 11 to 17 years</p> <ul style="list-style-type: none"> • 11–14 73.3% • 15–17 26.7% <p>Sex</p> <ul style="list-style-type: none"> • Female 48.9% • Male 51.1% <p>Ethnicity</p>	<p>Schools, Alberta, Canada n=45</p> <p>Limitations</p> <ul style="list-style-type: none"> • Small sample size • Limited to one geographical area • Findings may not be generalizable to those 	<ul style="list-style-type: none"> • Some did not report any harm/risks from using ECs. (Includes all ages) • One was unsure about the safety due to lack of studies surrounding EC vapor and ingredients. (Female, 15-year-old; • One did not think ECs were safe because of lack of studies regarding EC vapor and ingredients (Male, 17-year-old)

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<p>knowledge and attitudes of ECs among youth.</p>	<p>snowball sampling techniques</p> <ul style="list-style-type: none"> • Focus groups 	<ul style="list-style-type: none"> • European 33.3% • Asian 13.3% • Latin American 4.4% • African 35.6% • Missing 13.3% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for but described in results. Six had tried ECs in the past 	<p>outside of sampling frame</p>	<ul style="list-style-type: none"> • One participant thought that ECs were safer, less bad and did not smell as much. (Male, 14-year-old) • One participant never tried ECs but saw no risk as they heard it contained water. (Male, 17-year-old) • Two thought ECs were cool because everyone was doing it to fit in or follow a trend. (Female, 12-year-old; Female, 15-year-old) • Some reported EC use was an unhealthy behavior that would not help smoking cessation. (Includes all ages) • A few reported ECs were addictive. (Includes all ages) <p>Sources of EC information/exposure:</p> <ul style="list-style-type: none"> • ECs available anywhere (malls and convenience stores)
<p>Hilton et al. (2016)⁷⁰ UK</p> <p>Qualitatively explore how teenagers perceive ECs and how & why they do or do not use them.</p>	<p>Data collection: 2014/2015</p> <ul style="list-style-type: none"> • Purposive sampling • Focus groups 	<p>Age: 14 to17 years</p> <ul style="list-style-type: none"> • 14 23% • 15 14% • 16 29% • 17 34% <p>Sex</p> <ul style="list-style-type: none"> • Female 47.0% • Male 53.0% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for, smoking status described in results, but data not analyzed by status 	<p>Local community groups, Scotland and England n=83</p> <p>Limitations</p> <ul style="list-style-type: none"> • Findings may not be generalizable to those outside of sampling frame • Small sample size • Study did not distinguish views of smokers and EC users from non-users 	<ul style="list-style-type: none"> • Typically viewed ECs as substantially less harmful than cigarettes. • Potential health harms and unknown harmful ingredients were a common theme. • ECs are useful products for smokers, including teenage smokers, to quit or reduce cigarette use. • ECs safer alternative to cigarettes for teenagers. • EC smoke is less harmful than cigarettes. • ECs reported as less addictive than cigarettes <p>Sources of EC information/exposure</p> <ul style="list-style-type: none"> • Media (Facebook, Twitter, YouTube, and the internet) and stories from family and friends influenced adolescents' perception. • Marketing, appearance, packaging, and absence of health warning labels and other regulation

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<p>Johnson et al. (2017)⁵⁶ U.S.</p> <p>Examine youth's perceptions of ECs & how EC advertising, marketing & other exposure influence perceptions.</p>	<p>Data collection: Not stated</p> <ul style="list-style-type: none"> • Phenomenological • Purposive sampling • In-depth, qualitative telephone interview 	<p>Age: 12 to 17 years Mean age 14.96 years, SD 1.5</p> <p>Sex</p> <ul style="list-style-type: none"> • Female 56.0% • Male 44.0% <p>Ethnicity</p> <ul style="list-style-type: none"> • African American/Black 32.0% • White 52.0% • Another race 16.0% <p>User status</p> <ul style="list-style-type: none"> • Aware of ECs. Two had tried ECs. • Majority of sample never tried 	<p>Large urban tertiary care hospital, Washington, DC n=25</p> <p>Limitations</p> <ul style="list-style-type: none"> • Small sample size • Limited to 1 site within 1 geographical area • Findings may not be generalizable to those outside of sampling frame • Responses should be regarded within the context they were collected • Self-report 	<p>influenced adolescents' perception that EC use had low risk.</p> <ul style="list-style-type: none"> • 72% reported ECs as a safer alternative to cigarettes using words "cleaner" and "healthier" to describe EC use. • 44% reported ECs were less addictive than cigarettes. • One participant said it is "not likely" that ECs were addictive. • 88% reported ECs were addictive. • 28% said ECs are as addictive as cigarettes. • 84% reported ECs as harmful, or most likely harmful. <p>Sources of EC information/exposure:</p> <ul style="list-style-type: none"> • Through some type of media (n=18) (advertising on television, online or print). • Though the retail point of sale (n=12), including malls, major convenience stores, and gas stations (e.g., static ads and live demonstrations). • Through peers and family members (n=16). • Preferred sources of information were doctors (n=18) package information (n=7)
<p>Peters et al. (2013)⁶² U.S.</p> <p>Qualitatively investigate the beliefs & perceived social norms regarding</p>	<p>Data collection: 2012</p> <ul style="list-style-type: none"> • Phenomenological • Convenience sampling • Focus groups 	<p>Age: 15 to 17 years</p> <ul style="list-style-type: none"> • 15 11.0% • 16 53.0% • 17 36.0% <p>Sex: Male only</p> <p>Ethnicity</p> <ul style="list-style-type: none"> • African American 74.0% • Hispanic American 26.0% 	<p>1 high school, Houston, Texas n=47</p> <p>Limitations</p> <ul style="list-style-type: none"> • Small sample size • Limited by the number and types of questions asked • Findings may not be generalizable to those 	<ul style="list-style-type: none"> • Some reported ECs were healthier than cigarettes as cigarettes have more chemicals in them. • Some said the water vapor makes ECs safe. • Report ECs as healthier than cigarettes when asked what do their friends think (n=17, 36%). • ECs are so popular because they are healthier than cigarettes (n=14, 30%). • Youth use ECs as they are healthier than cigarettes (n=9, 19%).

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EC use.		User status	outside of sampling frame	
<p>Weishaar et al. (2016)⁷¹ UK</p> <p>Explore adolescents' perceptions of, & opinions about EC regulation.</p>	<p>Data collection: 2014/2015</p> <ul style="list-style-type: none"> • Grounded theory • Purposive sampling • Focus groups 	<p>Age: 14 to 17</p> <ul style="list-style-type: none"> • 14 23.2% • 15 14.6% • 16 29.3% • 17 32.9% <p>Sex</p> <ul style="list-style-type: none"> • Female 47.0% • Male 53.0% <p>User status</p> <ul style="list-style-type: none"> • Not sampled for but status described in results 	<p>Local youth organizations, Scotland and England n=83</p> <p>Limitations</p> <ul style="list-style-type: none"> • Findings may not be generalizable to those outside of sampling frame • Responses should be regarded within the context they were collected 	<ul style="list-style-type: none"> • One adolescent said that the National Health Service verified that one EC product was safe to use. • Inconsistent and inconclusive evidence of long-term harms of ECs. • Reported that the potential disadvantages of ECs were re-normalization of smoking-like behavior, increased attractiveness of a potentially harmful product. • One adolescent hypothesized that viewers of EC advertisement might think "ECs are fine because they are advertised, so the government thinks they are alright". <p>Sources of EC information/exposure:</p> <ul style="list-style-type: none"> • Aware of products on the National health service • Point of sale advertising • Handing out EC products to trial • Use of ECs in public places- a type of free advertising

EC, e-cigarette; UK, United Kingdom.

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Appendix Table 2. Data Extraction Proforma

Authors Year	Study design	Country	participants	Sample size and pool	Study aim	Response rate	Sampling and administration method	Health knowledge and beliefs outcomes	Limitations



Appendix 1. Joanna Briggs Institute Checklists

JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies

Reviewer.....Date.....

Author.....Year.....Record Number.....

	Yes	No	Unclear	Not applicable
1. Were the criteria for inclusion in the sample clearly defined?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Were the study subjects and the setting described in detail?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Was the exposure measured in a valid and reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were objective, standard criteria used for measurement of the condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were confounding factors identified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Were strategies to deal with confounding factors stated?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were the outcomes measured in a valid and reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info

Comments (Including reason for exclusion)



JBI Critical Appraisal Checklist for Cohort Studies

Reviewer..... Date.....

Author..... Year..... Record Number.....

	Yes	No	Unclear	Not applicable
1. Were the two groups similar and recruited from the same population?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Was the exposure measured in a valid and reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were confounding factors identified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were strategies to deal with confounding factors stated?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were the outcomes measured in a valid and reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Were strategies to address incomplete follow up utilized?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info

Comments (Including reason for exclusion)



JBI Critical Appraisal Checklist for Qualitative Research

Reviewer.....Date.....

Author.....Year.....Record Number.....

	Yes	No	Unclear	Not applicable
1. Is there congruity between the stated philosophical perspective and the research methodology?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Is there congruity between the research methodology and the research question or objectives?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Is there congruity between the research methodology and the methods used to collect data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Is there congruity between the research methodology and the representation and analysis of data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Is there congruity between the research methodology and the interpretation of results?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Is there a statement locating the researcher culturally or theoretically?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Is the influence of the researcher on the research, and vice-versa, addressed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Are participants, and their voices, adequately represented?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info

Comments (Including reason for exclusion)



JBI Critical Appraisal Checklist for Randomized Controlled Trials

Reviewer.....Date.....

AuthorYear.....Record Number.....

	Yes	No	Unclear	NA
1. Was true randomization used for assignment of participants to treatment groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Was allocation to treatment groups concealed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Were treatment groups similar at the baseline?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were participants blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were those delivering treatment blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Were outcomes assessors blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were treatment groups treated identically other than the intervention of interest?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Were participants analyzed in the groups to which they were randomized?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Were outcomes measured in the same way for treatment groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Were outcomes measured in a reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info

Comments (Including reason for exclusion)
