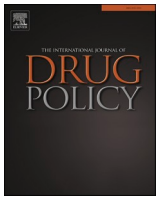
International Journal of Drug Policy 148 (2026) 105117

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo



The health effects of vaping and e-cigarettes: consensus recommendations

Erika Kouzoukas [a,1], Carolina Navas [a,1], Laurie Zawertailo [a,b,c], Chantal Fougere [a], Simon L Bacon [d,e], Nicholas Chadi [f,g], William K Evans [h,i], Ann McNeill [j], Osnat Melamed [a,b,k,l], Theo J. Moraes [m], Onyenyechukwu Nnorom [a,k,n], Robert Schwartz [b,n], Lion Shahab [o], Miranda Ween [p,q], Peter Selby [a,b,n,r,*]

[a] INTREPID Lab, Addictions Program, Centre for Addiction and Mental Health, Toronto, ON, Canada
[b] Institute for Mental Health Policy Research, Campbell Family Mental Health Research Institute, Centre for Addiction and Mental Health, Toronto, ON, Canada
[c] Department of Pharmacology and Toxicology, University of Toronto, Toronto, ON, Canada
[d] Department of Health, Kinesiology, and Applied Physiology, Concordia University, Montreal, QC, Canada
[e] Montreal Behavioural Medicine Centre, Centre intégré universitaire de santé et de services sociaux du Nord-de-l'Île-de-Montréal (CIUSSS-NIM), Montreal, QC, Canada
[f] Division of Adolescent Medicine, Department of Pediatrics, Sainte-Justine University Hospital Centre, Montreal, QC, Canada
[g] Department of Pediatrics, University of Montreal, Montreal, QC, Canada
[h] Department of Oncology, McMaster University, Hamilton, ON, Canada
[i] Ontario Health (Cancer Care Ontario), Clinical Lead, Smoking Cessation, Primary and Community-based Care, ON, Canada
[j] Addictions Department, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK
[k] Department of Family and Community Medicine, University of Toronto, Toronto, ON, Canada
[l] Institute of Medical Sciences, University of Toronto, Toronto, ON, Canada
[m] Division of Respiratory Medicine, Department of Pediatrics, SickKids & University of Toronto, Toronto, ON, Canada
[n] Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada
[o] Department of Behavioural Science and Health, Institute of Population Health, University College London, London, UK
[p] Department of Thoracic Medicine, Royal Adelaide Hospital, South Australia, Australia
[q] School of Medicine, University of Adelaide, South Australia, Australia
[r] Department of Psychiatry, University of Toronto, Toronto, ON, Canada

ARTICLE INFO

Keywords:
E-cigarettes
Vapes
Nicotine
Guidance
Public health
Consensus

ABSTRACT

Objective: To develop evidence-informed recommendations on the health effects of e-cigarettes to guide healthcare practitioners and the public to balance individual and population harm reduction.
Methods: Systematic and umbrella reviews investigating the health effects of e-cigarette use were conducted (September 2017 – January 2024). An international panel of subject matter experts ($n = 23$) and people in Canada with lived experience ($n = 7$) participated in a two-day, hybrid meeting, and used a consensus-based approach to develop recommendations. A guidance resource and four accompanying knowledge products were tested for usability with end users.
Results: Consensus was reached on 14 recommendations spanning four health effects: carcinogen exposure, cardiovascular health, respiratory health, and nicotine dependence. Quality of evidence was voted as ranging from high/moderate to moderate/low, and strength of most recommendations was voted as strong.
Conclusions: Guidance has been informed by best available evidence and expertise, providing direction to support decision-making. The use of established methods to evaluate divergent published literature combined with consensus-building methods among a range of stakeholders on vaping is possible. As higher quality evidence continues to emerge, recommendations will require iterative refinement.

* Corresponding author at: 1025 Queen Street West, Toronto, ON M6J 1H4, Canada.
E-mail address: peter.selby@camh.ca (P. Selby).
[1] co-first authors.

https://doi.org/10.1016/j.drugpo.2025.105117

Available online 23 December 2025

Introduction

Since their introduction into the global market nearly 20 years ago (Henningfield & Zaatari, 2010; Lichtenberg, 2017), e-cigarettes (also known as nicotine vapes) have undergone significant evolution in both the design of the devices and the types and concentrations of nicotine e-liquids available. There has also been an exponential increase in use, with about 6 % of Canadian (Statistics Canada, 2023) and American (Vahratian et al., 2025) adults reporting current e-cigarette use in 2023. Younger age groups indicate the highest rates of ever-use (Health Canada, 2023a, 2023b; Kramarow & Elgaddal, 2023), with 25.2 % of New Zealanders (Ministry of Health, 2024) and 9.3 % of Australian (Australian Institute of Health & Welfare, 2024) youth aged 18 to 24 years reporting daily e-cigarette use in 2023. Most youth in Canada (77 %), the United States (US; 72 %), and England (62 %) (Hammond et al., 2023) who used e-cigarettes in the past 30 days used e-liquids containing nicotine. The most recent WHO global estimate of e-cigarette use among adults (2020–2024) reports prevalence is highest in small, high-income countries, while large low- and middle-income countries report very low prevalence, partly due to older survey data and widespread bans (World Health Organization, 2025). For example, South-East Asia, home to 23 % of the global population, has an average adult prevalence of just 0.1 %, with some countries, such as Iran, reporting 0 % due to strict bans on sales and production (World Health Organization, 2025). In contrast, school-based surveys from 123 countries show a global adolescent prevalence of 7.2 %, equating to about 14.7 million users, although this is likely an underestimate due to missing data from some regions (World Health Organization, 2025). Adolescents use e-cigarettes at rates roughly nine times higher than adults, driven by aggressive industry marketing targeting youth through digital channels and flavoured products (World Health Organization, 2025). Despite growing health concerns and WHO's call to action, by the end of 2024, 62 countries still lacked any e-cigarette policy, and 74 had no minimum purchase age (World Health Organization, 2025).

The evidence on the long-term health effects associated with e-cigarette use is evolving, largely due to the relatively short period that these products have been available to consumers and the continuing evolution of the product (Razali, 2025). Emerging evidence suggests potential adverse health effects related to e-cigarette use (McNeill et al., 2022), however, the evidence is equivocal, making interpretation difficult. As a result, healthcare practitioners report feeling uninformed on the associated health effects of e-cigarette use among current users, the potential benefits and harms of e-cigarette use in comparison to smoking, and on what to recommend to their patients who use or are thinking of using e-cigarettes (Metcalf et al., 2022). This uncertainty is compounded by the lack of approved smoking cessation products and nationally recognized public health or clinical practice guidelines focused on the potential health-related harms and benefits associated with e-cigarette use.

To address this gap, Project VECTOR (*Vaping and Electronic Cigarette Toxicity Overview and Recommendations)* aimed to develop evidence-informed recommendations exclusively on the relative risk and health effects of e-cigarette use across the lifespan if possible and specific populations at particular risk, with a focus on carcinogen exposure, cardiovascular health, respiratory health, and nicotine dependence. These recommendations are intended for healthcare practitioners and people who use or are thinking of using e-cigarettes in countries where there are no authorized e-cigarettes for smoking cessation to help guide the decision-making process around use in relation to the health effects. This paper focuses on the consensus building methods we used to develop the recommendations on the health effects of e-cigarettes.

Method

The study protocol was not prospectively registered nor published. Given the level of uncertainty, disparate opinions, and complexity of e-cigarettes, we decided to use the RAND/UCLA Appropriateness Method, which draws on both Delphi and Nominal Group Technique to reach consensus (Fitch et al., 2001). The Delphi method is an iterative, anonymous, group-based process to elicit and aggregate opinion and develop consensus among experts, including those with lived experience (Hsu & Sandford, 2007; Linstone & Turoff, 1975). The Nominal Group Technique is a highly structured, face-to-face meeting format which empowers all members to be heard and have their opinions considered (Dalkey & Helmer, 1963; Delbecq et al., 1975; McMillan et al., 2016). In the RAND Appropriateness Method, participants review a focused literature summary, complete an initial Delphi-style rating round, discuss first-round results at a structured face-to-face meeting, followed by a re-rating of items lacking agreement (Fitch et al., 2001).

The methodology used in this project included literature reviews (October 2022 - May 2023), preparation of evidence briefs (May 2023), and a face-to-face consensus meeting using Delphi-style ratings to develop recommendations (June 2023). We then conducted an additional literature review (June 2023 - January 2024) to confirm the alignment of recommendations with recent evidence. To share these findings, we developed knowledge products for a variety of audiences. This study is reported in accordance with the ACCORD guidelines for consensus methods in biomedicine (Gattrell et al., 2024).

Preparatory research: literature review

The Ontario Tobacco Research Unit was contracted to conduct two literature reviews: (1) a systematic review summarizing and measuring the strength of evidence on four health effects of e-cigarette use (Kundu, Feore et al., 2025; Kundu et al., 2025a, b); and (2) an umbrella review of published review articles on health effects included in the systematic review and beyond. Articles were selected based on predefined inclusion/exclusion criteria (Kundu et al., 2023; Sanchez et al., 2023).

For the systematic review, an initial literature search was conducted to capture relevant evidence published between September 2017 and January 2023, focusing on four health effects: respiratory health, cardiovascular health, carcinogen exposure, and dependence (search strategy in Appendix A). This review aimed to include literature beyond the 2022 Office for Health Improvement and Disparities review which covered evidence published up to 1 July 2021 (McNeill et al., 2022). The initial search retrieved 6528 articles, of which 232 were included. Subgroup analyses explored health effects by population and use group.

A systematic review of reviews (umbrella review) was conducted for articles published between January 2018 and January 2023 and aimed to include literature beyond what was captured in the 2018 National Academies of Science, Engineering and Medicine report (National Academies of Sciences, 2018). Twelve health effects were examined. The initial search retrieved 2100 articles, of which 61 were included (search strategy in Appendix B).

Before the meeting, literature review evidence was synthesized into a brief (including evidence tables) and distributed to both panels. We designated four Subject Matter Expert (SME) panel members as topic leads based on their expertise. The remaining topic areas covered in the umbrella review, including toxicants, adolescent health, bone health, fetal health, oral and dental health, and otolaryngology, lacked sufficient evidence and did not advance to the recommendation development stage. Topic leads reviewed assigned evidence tables, and developed draft summary statements to present at the meeting. We circulated these statements to both the panels. Panel members reviewed the totality of the evidence, which included some population-specific studies to consider whether subgroup-specific recommendations could be made.

Participants

We convened one SME panel and one advisory group (AG) panel for this project. The SME panel was composed of 23 international

experts identified by the study team based on their area of expertise, strong academic or clinical breadth of experience, and participation in Health Canada's Scientific Advisory Board on Vaping Products (Appendix C). The panel was chaired by the principal author who had led several other Delphi and clinical smoking cessation guideline processes where consensus building was used. We included SMEs with diverse backgrounds, expertise, and perspectives on e-cigarette use, ascertained from publications, commentaries, and presentations, to prevent groupthink, minimize bias, and capture diverse viewpoints. The SME panel was responsible for participating in a two-day consensus-building meeting to review and deliberate the evidence from the literature reviews, drafting and voting on recommendations, and providing feedback on the draft guidance resource.

The AG panel was composed of 10 people, including 5 youth (aged 15 - 24) and 5 adults (aged 25 and above), with lived or living experience using e-cigarettes (Appendix D). We recruited members via promotional materials shared through existing peer advisory channels. We prioritized participation from those self-identifying as members of groups that are faced with greater systemic barriers and inequities to care, including Indigenous, racialized, and 2SLGBTQ+ communities, to ensure that diverse perspectives and intersectional identities were captured and integrated. Nine panel members self-identified as currently using e-cigarettes and 1 self-identified as having previously used. The AG panel was responsible for participating in the two-day, consensus-building meeting to draft and vote on recommendations with the SME panel. AG members were also invited to participate in usability testing of knowledge products through focus groups and surveys.

We also convened a group of five End Users representing a range of allied health and academic professions (e.g., pharmacist, respiratory therapist, scientist) across Canada, the US, and the United Kingdom (UK). End Users were identified and recruited through existing professional networks and invited to participate based on their clinical and academic experience relevant to tobacco and nicotine research, health systems, and knowledge translation. Their role was to support the development of project resources by providing expertise and clinical reflections through usability testing of the developed resources.

All panel members and End Users declared any conflicts of interest both at the project onset and upon completion. None declared receiving funding, honoraria, allowances, or other benefits from any e-cigarette or tobacco-related manufacturer. All eligible panel members and End Users were offered honoraria in recognition of their participation in the project. Across the engagement period of 18 months, response rates and attrition among panel members varied. Twenty-three SME and seven AG panel members participated in the two-day meeting, and of those, 22 (96 %) SME and four (57 %) AG panel members participated in the re-vote process.

Recommendation development process

At the project's outset, we offered a virtual orientation to both panels, and an additional training webinar to support AG members interested in learning about participating in a consensus-building process.

We hosted a two-day, consensus-building, hybrid (in-person and online) meeting in Toronto, Canada on June 1 and 2, 2023. Participants included SME and AG panel members and a neutral third-party facilitator with 25 years' facilitation experience and limited content-matter expertise to reduce bias. In addition, panel members used checklists from the GRADE and the Guidelines International Network to be consistent with evidence-based guideline development processes (McMaster GRADE Centre; Qaseem et al., 2012; Schumemann et al., 2013). The meeting's aim was to deliberate on the evidence and distill recommendations (Fig. 1).

At the meeting, SMEs deliberated on the evidence and summary statements, and began drafting evidence-based recommendations using the principles and criteria described in the GRADE handbook

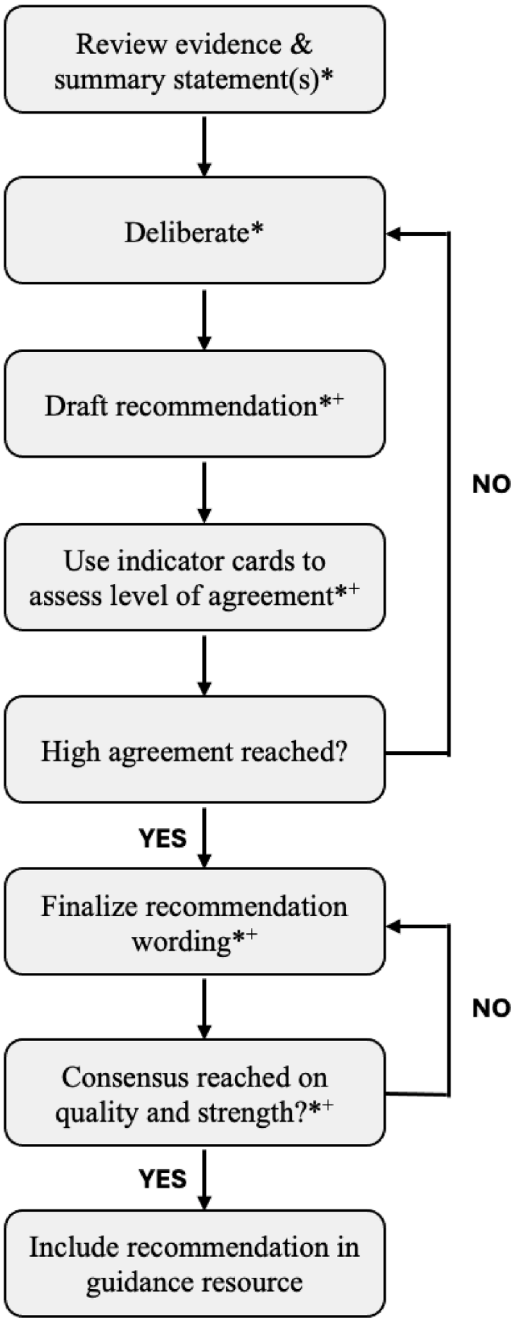


Fig. 1. A flowchart depicting the recommendation development process for the June 1–2, 2023 consensus-building meeting in Toronto, Canada. The asterisk (*) indicates the stages in the process where input/involvement from the SME was received. The addition sign (+) indicated the stages in the process where input/involvement from the AG was received.

(Schumemann et al., 2013). Each topic was given a half-day to allow for sufficient time for consensus building, recommendations development and voting. The AG panel provided feedback on the readability and accessibility of the draft recommendations.

Given the complexity of the topics and the nuanced health risks, SMEs used the continuum of harm described in the Lower-Risk Nicotine Use Guidelines to assess the harms associated with various forms of nicotine use (Centre for Addiction & Mental Health, 2025). As outlined in the guideline, combustible tobacco was most harmful followed by waterpipes, smokeless tobacco, heat-not-burn products, nicotine-containing e-cigarettes, unregulated nicotine patches, short-acting nicotine replacement therapy, and long-acting nicotine

replacement therapy. The harm continuum notes that while switching to e-cigarettes from combustible tobacco will reduce exposure to harmful chemicals and carcinogens, these products still pose a health risk. As such, the SMEs used the harm continuum to reflect on the e-cigarette risk to benefit ratio for the four health topics. This was particularly pertinent when evaluating the relative risk of e-cigarettes when comparing different subgroups, including people who never smoked and use e-cigarettes, concurrently smoke and use e-cigarettes, and quit smoking and switched to e-cigarette use.

Once recommendations were drafted, panel members used tri-coloured indicator cards, representing low, moderate, or high agreement, to express their level of agreement with the principles of the proposed recommendations. Once the majority of panel members were in high agreement, further substantive changes to the recommendations were halted. Finally, using Poll Everywhere (2023) a blind, online, anonymized voting tool, panel members voted on the (1) inclusion of the recommendations into the resource, (2) the strength of the recommendations, and (3) the quality of the evidence. Definitions for strength and quality are included in Table 1. A consensus cut-off point of 80 % was pre-established prior to voting. Following the meeting, we conducted an asynchronous, virtual re-vote via *REDCap* (Harris et al., 2019, 2009) survey to confirm the quality of evidence rating for two recommendations due to a miscount of votes at the hybrid meeting. Only panel members that attended the meeting were invited to participate in the re-vote.

For 14 of the final recommendations, we implemented a modified GRADE approach when voting on the quality of evidence. Consensus on a single quality of evidence level for these recommendations could not be reached through discussion by panel members in the meeting. To address this, a modified approach was taken wherein quality of evidence levels were combined in instances where panel member votes were split between 'high' and 'moderate' certainty and 'moderate' and 'low certainty' (i.e., high/moderate, moderate/high, moderate/low, and low/moderate); the level with the most number of votes appearing first.

Post-consensus literature update

Given the volume of emerging evidence in this field, an ongoing literature search was conducted in January 2024 to capture up-to-date evidence published up to January 2024 (Systematic Review) and September 2023 (Umbrella Review). For the systematic review, the ongoing literature search retrieved 1550 articles, of which 72 were included. For the umbrella review, the ongoing literature search retrieved 15 articles, of which four were included. Evidence tables were developed for the systematic review, umbrella review, subgroup analyses, and ongoing literature search.

Development of knowledge translation tools

At the conclusion of the consensus meeting, we compiled the evidence-informed recommendations that reached consensus into a draft guidance resource, which included general and recommendation-specific consideration statements to offer supplemental information and context. SME members iteratively reviewed the draft resource and revisions were made accordingly. Five knowledge products were also drafted simultaneously to translate the recommendations. AG members provided feedback through surveys and a facilitated focus group session and End Users provided feedback via surveys. This input informed both the guidance resource and accompanying knowledge products.

Results

Results from the two-day consensus-building meeting and re-vote are shown in Table 1.

Table 1
Clinical recommendations, with accompanying strength of recommendations and quality of evidence scores, voted on in June 2023 in Toronto, Canada and virtually.

Recommendation	Evidence Quality (% consensus)	Recommendation Strength (% consensus)
1. Cancer		
1A) People who do not smoke should not use e-cigarettes in order to avoid exposure to cancer-causing chemicals.	High/Moderate (92 %)	Strong (91 %)
1B) Tobacco users* who have been unable/unwilling to quit using current best evidence-based approaches, should switch completely to e-cigarettes to reduce exposure to tobacco-related cancer-causing chemicals.	High/Moderate (80 %)	Strong (75 %)‡ *Re*-vote: 92 %
1C) People who use e-cigarettes should avoid long-term use of e-cigarettes (where relapse to combustible cigarettes is not a concern) in order to reduce exposure to cancer-causing chemicals.	Moderate/High (88 %)	Strong (100 %)
2. Cardiovascular Disease		
2A) People who do not smoke should not use nicotine-containing e-cigarettes, to avoid exposure to cardiovascular toxicants.	High/Moderate (100 %)	Strong (100 %)
2B) People who do not smoke should not use nicotine-containing e-cigarettes, to avoid adverse effects on the cardiovascular system.	Moderate/High (100 %)	Strong (96 %)
2C) Tobacco users who have been unable/unwilling to quit using current best evidence-based approaches, should switch completely to nicotine-containing e-cigarettes to reduce exposure to cardiovascular toxicants.	Moderate/High (100 %)	Strong (91 %)
2D) Tobacco users who have been unable/unwilling to quit using current best evidence-based approaches, should switch completely to nicotine-containing e-cigarettes to improve measures of cardiovascular function.	Moderate/Low (96 %)	Strong (83 %)
3. Dependence		
3A) Those who do not smoke should not use nicotine-containing e-cigarettes as it may lead to dependence.	High/Moderate (100 %)	Strong (92 %)
3B) Tobacco users who have been unable/unwilling to quit using current best evidence-based approaches, should switch completely to nicotine-containing e-cigarettes to increase their chance of remaining smoke-free.	High/Moderate (96 %)	Strong (86 %)
3C) Tobacco users who have been unable/unwilling to quit using current best evidence-based approaches, should switch completely to nicotine-containing e-cigarettes to reduce their dependence.	Moderate/Low (89 %)	No Consensus†
3D) People who use nicotine-containing e-cigarettes should avoid long-term use (where relapse to combustible cigarettes is not a concern) as this maintains dependence.	Moderate/High (93 %)	Strong (96 %)
4. Respiratory Health		
4A) People who do not smoke should not use e-cigarettes in	High/Moderate (100 %)	Strong (96 %)

(*continued on next page*)

Table 1 (*continued*)

Recommendation	Evidence Quality (% consensus)	Recommendation Strength (% consensus)
order to avoid respiratory dysfunction and symptoms.		
4B) Tobacco users* with pre-existing respiratory diseases (e.g., COPD, asthma) who have been unable/ unwilling to quit using current best evidence-based approaches, should switch completely to e-cigarettes for better lung health.	Moderate (88 %)	Strong (76 %)‡ *Re*-vote: (88 %)
4C) People who use e-cigarettes should avoid long-term use (where relapse to combustible cigarettes is not a concern) to reduce exposure to respiratory toxicants and potentially minimize respiratory symptoms and dysfunction.	Moderate/Low (96 %)	Strong (96 %)

Quality of evidence grades. **High:** There is strong confidence in the evidence to predict actual outcomes. **Moderate:** There is strong confidence that the evidence is close to the actual outcomes. **Low:** The predicted outcomes in the evidence may be markedly different from the actual effects. **High/Moderate:** A consensus of the recommendation development group members designated the overall quality of the evidence as high or moderate, with a larger proportion rating the certainty of the evidence as high. **Moderate/High:** A consensus of the recommendation development group members designated the overall quality of the evidence as high or moderate, with a larger proportion rating the certainty of the evidence as moderate. **Moderate/Low:** A consensus of the recommendation development group members designated the overall quality of the evidence as moderate, low, or very low, with the largest proportion rating the certainty of the evidence as moderate. Strength of recommendation. **Strong:** implies that most or all individuals will be best served by the recommended course of action.

* Tobacco users as a term refers to individuals who use commercial combustible tobacco products, including cigarettes, cigars, hookah, or pipes. This recommendation will need adaptation if applied to children and adolescent tobacco users.

† Among the recommendation development group members, a consensus could not be reached regarding the strength of recommendation 3C in the Dependence section. The recommended course of action may or may not best serve all individuals.

‡ The percent consensus reached in the hybrid meeting.

Recommendations

Twelve recommendations, along with their associated evidence quality and strength of recommendation scores, were finalized during the meeting and two additional recommendations were finalized during the re-vote, for a total of 14. All proposed recommendations were included in the final list. Due to insufficient evidence on health effects across specific population groups, including adolescents, recommendations were developed to apply broadly to people who use or are thinking of using e-cigarettes.

While finalizing the draft guidance resource, an ongoing literature review was being completed in tandem to capture new evidence. No novel findings emerged, and the recommendations remained consistent with the content that was voted on and aligned with the latest available evidence. Topic areas that lacked sufficient evidence for recommendation development were instead incorporated as additional considerations in the guidance resource.

Knowledge translation tools

The guidance resource was completed in March 2024 and included 14 recommendations spanning four health effects (carcinogen exposure, cardiovascular health, dependence, and respiratory health), along with seven general e-cigarette use considerations and six additional considerations for areas where evidence was insufficient to support formal recommendations. Three AG members and four End Users provided feedback that shaped the clarity and accessibility of the resource. For example, AG members suggested replacing technical terms such as "respiratory dysfunction" with plain-language alternatives like "lung health". These changes were integrated into the final guidance resource to ensure alignment with evidence while improving usability for diverse audiences.

Five knowledge products were developed alongside the guidance resource as tools to translate the consensus recommendations (e.g., infographic, frequently asked questions document). These products were also informed by AG and End User usability testing, particularity feedback on graphic design elements, language, and framing. For example, End Users favored knowledge products tailored by health effect or by use behaviour (e.g., exclusive e-cigarette use, using e-cigarettes for combustible tobacco cessation) as opposed to by target population, and AG members advised against using imagery that depicted active vaping.

The complete guidance resource and full suite of knowledge products are available for download on The INTREPID Lab website (https://intrepidlab.ca/en/Pages/Project-VECTOR.aspx) in English and French.

Discussion

In the absence of evidence-informed guidelines on the absolute and relative health effects and polarized opinions about the value of e-cigarettes, we successfully combined recommended methods (e.g., GRADE, RAND appropriateness method). This resulted in pragmatic recommendations, developed by combining literature review findings with the expertise of both the SME and AG panels, that can guide healthcare practitioners and people who use e-cigarettes, ideally in a shared decision-making process, to evaluate the absolute and relative harms of e-cigarettes. The resultant enablers include tailored knowledge translation tools designed to bridge the gap between evidence and action, empowering patients to engage directly in self-care, and make informed decisions around the use of these products. Project VECTOR thus presents clear, actionable behaviours of the nuanced analysis of the complex e-cigarette risk-to-benefit ratio. For example, while e-cigarette use may increase the number of people exposed to nicotine, potentially impacting tobacco control efforts, it simultaneously provides a lower-risk alternative to smoking combustible tobacco for people who have experienced difficulty in quitting using other methods.

Clinical relevance

Based on the outlined recommendations, people who do not currently smoke should avoid e-cigarette use (Table 1: recommendations 1A, 2A, 3A, 4A). Tobacco users who have been unable or unwilling to quit using the best evidence-informed approaches should switch completely to e-cigarettes to reduce tobacco-related harm and avoid long-term use, where relapse to combustible cigarettes is not a concern. Adolescent populations have an elevated absolute risk from exposure to e-cigarettes and should avoid use as much as possible; this is especially true for those who never used any form of tobacco products.

Comparison with other reports and guidelines

While the evidence base on e-cigarette use-associated health effects has grown since the publication of the 2018 National Academies of Science, Engineering and Medicine and the 2022 Office for Health Improvement and Disparities reviews (McNeill et al., 2022; National Academies of Sciences, 2018), the findings outlined in those reports are supported by Project VECTOR. Our recommendations also align with recent UK guidance, particularly NICE NG209, and with US statements which acknowledge that using e-cigarettes as a complete substitute for combustible tobacco may reduce harm for adults who smoke (American Cancer Society, 2024; National Institute for Health & Care Excellence,

2025). Further, Project VECTOR's emphasis on a continuum of harm also aligns with evidence-based guidance on e-cigarette cessation (Zawertailo et al., 2023) and lower-risk substance use, including nicotine (Centre for Addiction & Mental Health, 2025), cannabis (Fischer et al., 2022), and alcohol (Fischer et al., 2017). These recommendations are also broadly consistent with the Canadian Task Force for Preventative Health Care guideline for smoking cessation (Thombs et al., 2025) which makes a conditional recommendation against offering e-cigarettes for cessation for several reasons (i.e., potential for long term use, lack of regulated cessation products, tobacco industry ownership, potential for increase youth addiction) but supports shared-decision making for adults unwilling or unable to quit smoking using other approved options (Thombs et al., 2025). The unique nature of the guideline is the explicit focus on evidence for health harms and the role of harm reduction via complete substitution, rather than on complete cessation of all nicotine use.

Consensus-building process

We followed a similar methodology used in the Lower-Risk Cannabis Use Guidelines and Lower-Risk Nicotine Use Guidelines, whereby evidence was distilled into draft recommendations and subsequently assigned scores (Centre for Addiction & Mental Health, 2025; Fischer et al., 2022). In alignment with the Lower-Risk Nicotine Use Guidelines, the GRADE framework (Schumemann et al., 2013) was applied to provide a systematic approach to develop recommendations, and combined with the RAND Appropriateness Method. Together, these approaches were complementary and allowed for methodological rigor, with GRADE supporting explicit evidence appraisal and recommendation strength, and the RAND Appropriateness Method enabling iterative, consensus-oriented decision-making

We designed our Delphi procedures to meet the 4 core and 12 additional quality indicators of the Delphi Critical Appraisal Tool (Khodyakov et al., 2023). We maintained anonymity of individual responses through secure, digital software and reported only aggregate results. With permission, we disclosed the identities and affiliations of SME panel members to enhance transparency, while keeping their individual votes confidential (Appendix C). AG member names, vaping status, and age group were disclosed; however, any affiliation information was not disclosed to protect privacy and mitigate power imbalances (Appendix D).

A strength of this approach is that structured frameworks (GRADE and RAND Appropriateness Method) provided transparency and rigor to the process and enabled both SME and AG panels with diverging perspectives to converge on recommendations. At the same time, consensus-building can also present challenges in simplifying complex concepts to achieve agreement and in balancing competing perspectives of concepts. For example, consensus was not reached on the strength of Recommendation 3C (Table 1). There was extensive discussion around the phrase "reduce their dependence". The debate focused on (1) whether "dependence" should be contextualized by product (i.e., e-cigarettes) or the addictive component (i.e., nicotine), and (2) how dependence varies by population – for example, youth who occasionally smoke and switch to e-cigarettes may increase their level of dependence (Gomes et al., 2024), whereas older adults with longer smoking histories who completely switch to vaping may reduce their dependence on combustible tobacco (Shiffman & Goldenson, 2023). Additionally, e-cigarettes are evolving and the dependence potential of different products varies. Ultimately, the panel agreed to keep the recommendation with a footnote emphasizing that practitioners should evaluate the suitability of treatment approaches on a case-by-case basis; this procedure was followed to prevent forced consent. We also used controlled feedback and contingency procedures (e.g., secure post-meeting voting if an in-person error occurred) to preserve data integrity in a busy in-person meeting. In fields with emerging evidence and rapidly-evolving products that vary widely as e-cigarettes do, consensus processes may therefore require mechanisms for ongoing review and revision to remain most relevant and up-to-date.

Usability testing within consensus-building

Usability testing with AG members and End Users supported the development of practical recommendations and knowledge products that have the potential to make a greater public health impact (Beames et al., 2021). While these products have not yet been formally evaluated, they are presented as examples of knowledge translation tools stemming from the consensus process.

This stage exposed tensions that exist between accuracy and accessibility, particularly how terminology and visuals influence how recommendations are interpreted. More critically, usability testing showed how consensus-building must extend past deliberation to encompass how recommendations are further communicated and understood by broader audiences. Recommendations, even if grounded in evidence and expert consensus, may lose their credibility and relevance if presented in inaccessible ways. Embedding usability testing of knowledge translation tools as a part of the consensus process ensured that recommendations did not remain siloed within academic or clinical spaces, but could be communicated in ways that supported understanding and informed decision-making.

Strengths and limitations

Project strengths include the use of accepted frameworks to build consensus and guideline development. In particular, involvement of the international membership of the SME panel with disparate published opinions on e-cigarettes allowed for a broad range of perspectives from areas outside of Canada (i.e., US, UK, Australia and New Zealand) to be captured and reflected in the recommendations. In addition, engagement with the AG panel allowed for the inclusion of a lived experience perspective of people who use or previously used e-cigarette products. The integration of the lived experience perspective in data synthesis and consensus-building activities is an emerging area and as such, this project has generated lessons learned to add to this growing body of research. AG participation varied, with the highest levelsin the June 2023 hybrid meeting, and lowest levels in the focus groups. In the future, AG members should be included during the proposal and planning phases of the project to ensure participation formats are appropriate and accessible (Beames et al., 2021). AG participation in the deliberation portion of the consensus-building meeting was also limited, highlighting a need for a greater focus on empowering members to engage in the decision-making process. Possible approaches include creating more space for members to actively draw from their experiences in meaningful ways and providing more opportunities to build research skills (Gupta et al., 2023).

Several limitations to the project methodology were also revealed throughout the process. First, while the SME panel included members with diverse backgrounds and expertise, it is not clear whether a balanced range of perspectives was achieved. This speaks to the larger issue of researchers in developing countries not being funded to conduct studies and publish research to be subsequently recognized as experts in this emerging field. Additionally, the smoking status of AG panel members was not collected. As the recommendations were based on the relative risk of e-cigarettes compared to combustible tobacco, future projects should collect this information. Second, voting did not account for active abstention, as consensus was based on 80 % agreement among those who voted. Third, due to the limited and inconclusive evidence available, the quality of evidence scores were aggregated in order to reach consensus, which is a deviation from the GRADE protocol (Schumemann et al., 2013). Fourth, the state of evidence on the long-term health effects of e-cigarette use currently remains limited. As the evidence continues to evolve, the recommendations, considerations, and resources will need to be updated. Finally, it is unclear how the

recommendations can be applied to youth, specifically adolescents, who represent an important sub-group of individuals who use e-cigarettes. As new evidence continues to emerge, healthcare practitioners are encouraged to re-evaluate the harm-to-benefit ratio of e-cigarettes. Other researchers using consensus building techniques need to ensure that the voices of the AG can be heard during the expert consensus building deliberations beyond anonymous voting and have ways to retain them for the duration of the project.

Public health implications

Project VECTOR recommendations and associated knowledge translation tools were developed within a Canadian context, however, many countries are facing the growing public health burden posed by e-cigarettes and may benefit from the findings. Globally, there are differences in regulatory landscapes across jurisdictions, including promoting e-cigarettes as smoking cessation aids, regulating e-liquid ingredients, classifying nicotine as a dangerous poison and banning the sale of e-cigarettes to youth (Campus et al., 2021; Erku et al., 2020; Health Canada, 2023c; Morphett et al., 2023; Warner et al., 2023). Project VECTOR resources are based on the best available evidence and the principles of the recommendations and guidance are applicable internationally where e-cigarettes are available. However, our SME panel was composed entirely of members from high-income countries which limits the representation of perspectives from other regions where e-cigarette use is increasing, including Asia (Gordon, 2023), Africa (Jerzyński & Stimson, 2023), and Latin America (Izquierdo-Condoy et al., 2025). As such, these recommendations, which have been developed within high-income contexts, may not translate directly across settings. Instead, they may serve as a framework to be adapted and validated with local expertise and evidence. This guidance could inform policy makers in countries considering regulating the sale of e-cigarettes as a harm reduction tool against the use of combustible tobacco. More importantly, it highlights the need for the development of a pharmaceutical grade product that can be rigorously tested, approved, and promoted to adults who smoke and their health care practitioners as an aid to smoking cessation whilst protecting people who do not smoke from the recreational use of e-cigarettes. Future consensus-building efforts should prioritize inclusion of SMEs, AGs, and end users from low- and middle-income countries to ensure that emerging guidance is globally relevant.

There is a need for further research assessing the health effects of e-cigarette use, including those investigated in this project and beyond. In addition, further research should investigate sex-specific (i.e., biological), gender-specific (i.e., social), and population-specific (e.g., youth, income, race, tobacco use status) characteristics, as well as the intersections between these factors to ensure the applicability and accessibility of findings. Research studies with robust data analysis and evaluation frameworks will support more comprehensive investigation of these social factors and how they interact with e-cigarette use. Moreover, there needs to be consensus on the definition of e-cigarette use behaviours, including whether it should be defined as an addiction or dependence for better precision in scientific studies and to compare and contrast it to the addiction of combustible cigarettes (McNeill et al., 2022).

Conclusion

The recommendations developed through Project VECTOR, which have been informed by both evidence and lived experience, provide directions that healthcare practitioners and consumers can use when making recommendations or decisions about e-cigarette use. Since the completion of Project VECTOR, additional high-quality evidence (Herzog et al., 2024) continues to be published. Lastly, the Canadian Task Force on Preventive Health Care's guideline on tobacco smoking cessation for adults situates e-cigarettes similarly to Project VECTOR (Thombs et al., 2025). These new findings further support the conclusions of Project VECTOR, reflecting the fast pace and ever-evolving landscape of e-cigarette research.

Funding information

This work was funded by Health Canada's Substance Use and Addictions Program (funding no #2223-HQ-000150, 2022). The funder did not influence the project design, conduct, or outcomes and was not involved in the preparation, review, or approval of this manuscript.

CRediT authorship contribution statement

Erika Kouzoukas: Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation. **Carolina Navas:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation. **Laurie Zawertailo:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Chantal Fougere:** Writing – review & editing. **Simon L Bacon:** Writing – review & editing. **Nicholas Chadi:** Writing – review & editing. **William K Evans:** Writing – review & editing. **Ann McNeill:** Writing – review & editing. **Osnat Melamed:** Writing – review & editing. **Theo J. Moraes:** Writing – review & editing. **Onyenyechukwu Nnorom:** Writing – review & editing. **Robert Schwartz:** Writing – review & editing. **Lion Shahab:** Writing – review & editing. **Miranda Ween:** Writing – review & editing. **Peter Selby:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

L. Zawertailo declares providing an expert report on vaping to Cambridge LLP and reports receiving funding for e-cigarette research from the Ontario Ministry of Health, Health Canada and CAMH womenmind. N. Chadi declares receiving CIHR grant for tobacco cessation study using NRT. O. Melamed declares receiving grant/research support from AMS Healthcare, CAMH womenmind and CIHR. T. J. Moraes declares receiving grant funding for vaping related research from CIHR and PSI and funding from other agencies for non-vaping research. L. Shahab declares having consulted for pharmaceutical companies that manufacture smoking cessation medication (Johnson & Johnston, Pfizer) and receiving funding from Pfizer (manufacturer of smoking cessation medications). P. Selby declares receiving honoraria for speaking engagements from Government of Singapore, Quitpath Yukon, Vitalité Health Network New Brunswick, Canadian Public Health Association, Horizon Health Network, The E-Cigarette Summit UK, Canadian Society of Addictions Medicine and University of Ottawa for presentations related to vaping. Through an open tender process, Kenvue (previously Johnson & Johnson), Haleon, and Pfizer Inc. are vendors of record for providing smoking cessation pharmacotherapy, free or discounted, for research studies in which Selby is the principal investigator or co-investigator. E. Kouzoukas, C. Navas, C. Fougere, S. L. Bacon, W. K. Evans, A. McNeill, O. Nnorom, R. Schwartz and M. Ween declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. COI for panel members are available upon request.

Acknowledgments

The authors thank Rubén M.J. Tarajano for the development and design of the knowledge products as well as Myra Fahim and Elise Tanzini for providing their leadership and guidance in the development of the project methodology.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2025.105117.

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