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Effective interventions to prevent youth vaping behaviours: a rapid review

Ana Paula Belon ,[1] Laura Nieuwendyk,[1] Tasha Allen,[2] Melissa Worrell,[3] Candace I J Nykiforuk [1]

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[1]School of Public Health, University of Alberta, Edmonton, Alberta, Canada
[2]Tobacco, Vaping & Cannabis Program, Alberta Health Services, Edmonton, Alberta, Canada
[3]Tobacco, Vaping & Cannabis Program, Alberta Health Services, Calgary, Alberta, Canada

Correspondence to
Dr Candace I J Nykiforuk; candace.nykiforuk@ualberta.ca

ABSTRACT

Objective To identify effective policies and non-policy interventions preventing youth vaping behaviour initiation and assess their effectiveness by the level of intrusiveness and subpopulations.

Design This systematic rapid review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Data sources Searches on MEDLINE and APA-PsycINFO for studies published between January 2019 and November 2023.

Eligibility criteria Observational, intervention or mixed-method studies and quantitative systematic reviews/meta-analyses measuring the impact of interventions on youth (6–18 years) who never vaped or who had experimentally vaped.

Data extraction and synthesis A predesigned form was used to extract data. To classify interventions by levels of intrusiveness, we used the *PLACE Research Lab Intervention Ladder Policy Analysis Framework*. We applied PROGRESS-Plus (Place of residence, Race/ethnicity/culture/language, Occupation,Gender/sex, Religion, Education, Socioeconomic status, Social capital, and additional context-specific factors) for an equity analysis. Methodological quality was assessed using the Effective Public Health Practice Project Quality Assessment Tool.

Results 20 studies were included: 45% were experiments or quasiexperiments, 85% reported data from the USA, 65% were non-policy interventions and 40% and 35% measured susceptibility and attitudes and behaviours related to vaping, respectively. Considering the level of intrusiveness, 45% of the studies provided information and 25% eliminated choices. Overall, the certainty of evidence was low. The effectiveness of interventions regarding their level of intrusiveness varied by each outcome. No clear pattern was found between the level of intrusiveness and intervention effectiveness, suggesting that overall, the studied interventions positively changed youth vaping behaviours. Some interventions had positive effects on multiple outcomes. Equity-related findings suggested that younger youth may be less responsive to the interventions. Recommendations for action are provided.

Conclusions We suggest that combining multiple interventions targeting different levels of intrusiveness and outcomes may be more effective in preventing youth vaping behaviours. Also important is to tailor programmes to younger youth to better meet their needs.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This rapid review included both policy and non-policy interventions aimed at preventing vaping initiation among youth aged 6–18 years.
⇒ It analyses the effectiveness of interventions by their level of intrusiveness to individual autonomy and their equity focus and impacts.
⇒ Following the rapid review methodology, the search was restricted to only two databases and a 5-year period.
⇒ Analysis and comparisons were limited due to data heterogeneity.

INTRODUCTION

Youth vaping statistics in Canada are alarming. Data from a national, school-based survey from 2021 to 2022 report that almost one-third of grade 7–12 students have ever tried electronic cigarettes in Canada.[1] In addition, 17% of grade 7–9 students have also experimented with vaping.[1 2] Regular vaping with (48%) and without (21%) nicotine was perceived as being of great risk among grade 7–12 students.[1]

Health risks associated with vaping include pulmonary (eg, lung injury and bronchitis), cardiovascular (eg, high blood pressure and myocardial infarction)[3–5] and periodontal, dental and gingival diseases.[6] Ocular injuries (eg, corneal staining)[7] and severe burns caused by device malfunctions[8] have also been reported. Evidence also suggests that vaping may amplify mental health problems among youth.[9–11] Due to their toxicity and dependence,[11] vaping with nicotine or tetrahydrocannabinol has been associated with nicotine addiction, a higher risk of future cigarette smoking, increased cannabis use and problematic use of legal and illegal substances among older-aged youth.[12] 20% of Canadian students in grades 7–12 who vaped with nicotine in the last month reported they did so because they feel addicted to it.[1]

Given the rise of youth vaping and the harmful effects associated with the early onset of e-cigarette use[10] in high-income

countries, a number of policies and programmes have been introduced to curb vaping behaviours among the general population and youth specifically. Examples of such interventions include smoke-free public spaces; no display of vaping products in retail stores; no advertisement, promotion or sales of vaping products online; and awareness and education.[13] Previous knowledge syntheses described the effectiveness of specific policies (eg, restrictions on vaping in public spaces)[14] or in specific contexts (eg, the USA).[15] A recent systematic review reported that regulatory strategies, such as flavour bans and taxation, were associated with positive changes in youth vaping in high-income countries.[16]

This rapid review adds to the growing literature on youth vaping by synthesising evidence on non-policy interventions (eg, including behavioural, educational or organisational programmes or initiatives) in addition to policies (as population-level interventions) and the inclusion of other primary outcomes beyond vaping among youth. Considering the variety of vaping prevention interventions (eg, from prohibiting access to raising awareness of health risks), there remains a knowledge gap in assessing intervention effectiveness in light of the level of restriction to public freedom each type of intervention imposes on the individual, as well as equity considerations. Therefore, the purpose of this rapid review was twofold: (1) to determine what policy and non-policy interventions were effective to prevent initiation of vaping behaviour among youth and (2) to examine their effectiveness by the level of intrusiveness and by population groups.

METHODOLOGY

This project was undertaken by researchers in the Centre for Healthy Communities (CHC) in partnership with Alberta Health Services (AHS; a provincial healthcare authority in Alberta, Canada). AHS was interested in identifying effective interventions to prevent vaping initiation among children and youth to inform their future interventions. CHC and AHS chose a rapid review methodology to systematically identify relevant recent studies in a timely manner to inform programme and policy-making. Rapid review methodology streamlines the systematic review process and engaging end-user decision-makers in the entire review process to provide results in a short timeframe while still rigorously synthesising evidence to support timely decision-making.[17] We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist.[18] The protocol of this rapid review was not registered in any database. This rapid review did not involve patients or the public.

Search strategy

The search was structured around three main concepts: youth population, vaping and prevention. With the support of the project team, a research librarian designed the search strategy (which was independently peer reviewed by two health librarians) and conducted the searches. Literature searches were limited to the English language and for the period of January 2019–November 2023. Searches were completed in the following electronic databases: MEDLINE (via Ovid) and APA PsycINFO (via Ovid). Online supplemental table S1 provides the full search strategy used in both databases.

Study selection

The study types eligible for inclusion were observational studies, intervention studies, mixed-method studies and quantitative systematic reviews/meta-analyses. The population of 'youth' was defined as people aged 6–18 years who never vaped or who had experimentally vaped. Vaping included any device with a power source and heating component used to inhale or exhale aerosolized nicotine, cannabis, flavoured water, liquids or chemicals; for example, vape pens, electronic nicotine delivery systems (ENDS).[19] Preventive interventions measuring impact on youth vaping initiation or delay of experimentation through the following outcomes were included: youth attitudes, beliefs, knowledge and/or behaviours regarding the harms, risks and/or dependence on vaping; youth intentions or willingness to avoid experimenting or initiating vaping; or youth reactions or perceptions of the effectiveness of such interventions. Importantly, given that policies reach the entire population, the inclusion criterion for population related to vaping use was not applied. That is, studies reporting on policies may have provided combined results for users and non-users of vaping devices. The countries were limited to the Organization for Economic Co-operation and Development list and five selected United Nations developed economies. Online supplemental table S2 presents the inclusion and exclusion criteria.

Screening was done through Covidence software.[20] Two reviewers independently screened 10% of all included abstracts, resolving disagreements through discussion. When needed, another team member helped resolve disagreements. When 100% agreement was reached, the remaining set of the included abstracts were divided into two subsets. Each reviewer completed the screening of their subset. The same process was followed for screening of full-text articles.

Data extraction and analysis

Two reviewers each extracted data from 50% of the included studies into a standardised data extraction form developed for this study (see online supplemental table S3 for the template used). Extracted data were verified by the second reviewer, checking for completeness and correctness. The data items included but were not limited to study design, country, duration of intervention, main outcome measures, other measures that may be relevant and outcome results. Disagreements were resolved through discussion between the two reviewers who met regularly during the data extraction process. When needed, another researcher met with the reviewers to help resolve disagreements. We conducted a qualitative

synthesis of the included studies given their heterogeneity regarding study design, interventions and outcomes. In the qualitative synthesis process, periodic meetings with the team were held to discuss and compare the characteristics, measures and outcome results reported in the included studies. Some of the primary outcome measures were combined for more robust data interpretation.

During the data extraction, the reviewers classified the interventions reported in the included studies according to their level of intrusiveness to individual autonomy. To do this, they applied the *PLACE Research Lab Intervention Ladder Policy Analysis Framework*,[21] which is an adapted version of the *Nuffield Council on Bioethics Intervention Ladder*[22] typology (eight levels) for population health interventions. The adapted version contains an additional level named *reorient government action* to include policy options that are more related to the way governments operate and, therefore, do not necessarily impact individuals' autonomy. The nine levels move from low (ie, 1. *reorient government action*) to high levels of restriction on personal autonomy and public freedoms (ie, 9. *eliminate choice*). As each reviewer was responsible for 50% of the dataset for data extraction, the second reviewer verified the classification. Conflicts in the classification were resolved through discussions with the entire research team.

The focus and impacts of the interventions were examined through an equity lens. The reviewers used PROGRESS-Plus (Place of residence, Race/ethnicity/culture/language, Occupation,Gender/sex, Religion, Education, Socioeconomic status, Social capital, and additional context-specific factors)[23] to identify social factors that may have been considered in the design of the intervention and social and health inequality findings that were reported by the source studies' authors. Two reviewers independently assessed each included study for methodological limitations using the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies.[24] Reviewers resolved discrepancies through mutual discussion, and when required, another researcher helped to achieve consensus. Materials used in this review are available on reasonable request.

Patient and public involvement

None.

RESULTS

The search identified 2089 studies. After removing duplicates, the titles and abstracts of 1729 studies were screened. Of 206 studies selected for full-text screening, 20 papers[25–44] were included in this review (figure 1). Table 1 presents the main characteristics of the 20 included papers. Most studies used experimental and quasiexperimental designs (45%), were conducted in the USA (85%) and were non-policy interventions (65%). The most common primary outcomes studied were susceptibility to vaping (40%) and attitudes and behaviours related to vaping (35%). In the evaluation of the methodological limitations of the 20 included studies, four were rated as strong, five as moderate and 11 as weak. Regarding the intervention level of intrusiveness, interventions *providing information* (45%), *eliminating choices* (25%) and *guiding choices by changing default policies* (20%) were the most targeted. Online supplemental table S4 provides a detailed summary of each included study, reporting findings on outcomes of interest, levels of intrusiveness of the interventions and methodological quality. Online supplemental table S5 summarises the main characteristics of the interventions, including intervention details, who delivered it, how it was delivered, target population, data collection methods and duration of the intervention.

Table 2 reports on the impact of the interventions among youth who have never used vaping products or devices or youth who have experimented with vaping (as defined by the source studies' authors) by the type of policy. The positive symbol (+) indicates interventions that reported expected outcomes. For instance, the vaping prevention messages that public health organisations developed were associated with greater perceived message effectiveness among youth who had never used vaping products and devices (as expected by the source studies' authors).[35] The negative symbol (−) is used for those interventions that may have unexpectedly caused harm or had other unintended outcomes. An example is the exposure to health warning messages on cigarettes and ENDS,[41] which was associated with higher ENDS initiation—a finding not expected by the source studies' authors. The number zero (0) is applied for interventions that did not have any expected impact on the outcomes. This is exemplified in a study[38] examining the introduction of excise tax on e-cigarette products that did not lead to a decrease in youth e-cigarette use over time. The analysis of findings in each column separately shows that with few exceptions (eg, household rules allowing the use of tobacco products inside the home were not effective in reducing ever-use and/or intention), most interventions had a positive impact on the specific studied outcomes.

Level of intrusiveness of the interventions

Table 3 summarises the overall effectiveness of combined policies and non-policy interventions on changing the studied outcomes under each level of intrusiveness.[21] Interventions that *eliminate choice* effectively changed ever-use and/or initiation, susceptibility, beliefs and perceptions and attitudes and behaviours. Interventions that *provide information* were effective in changing all studied outcomes, except for ever-use and/or initiation for which findings were inconclusive. The interventions that *guide choices by changing default policy* overall showed positive impacts. For the *enable choice* level, the findings were mixed. For the levels of intrusiveness with only one study, those in the *restrict choice* and *reorient government action* levels were effective. The intervention that aligned with the *guide choices through disincentives* level was not effective. Finally, the study aligned with the *do nothing or simply monitor the current situation* level reported mixed findings for the two interventions analysed.

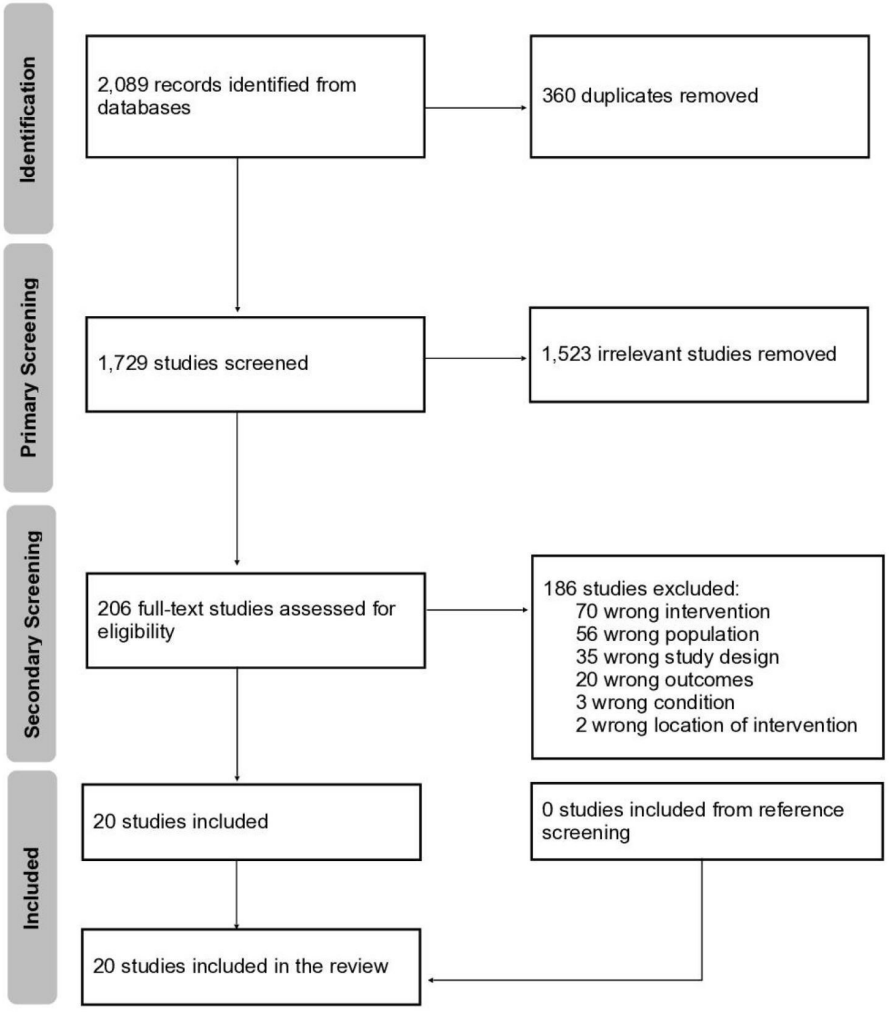

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses chart of the rapid review screening process.

Considering each outcome separately, for example, interventions that *eliminate choice, restrict choice, guide choices by changing default policy, enable choice and reorient government action* effectively changed youth ever-use and initiation. Positive changes in attitudes and behaviours were found in interventions that *eliminate choice* and *provide information*.

Equity-related findings

Only one study explicitly targeted a socially disadvantaged population group for participation in the intervention: Cartujano-Barrera *et al*'s study[29] invited only black and Latino youth. Further, seven studies[26 27 30 37 41–43] (of which two were studies reporting on policies)[30 43] estimated the differential impacts of the interventions on specific subpopulations, defined by gender/sex, age, race/ethnicity and socioeconomic status (table 4).

Findings were mixed on the effectiveness of interventions relative to youth's biological sex[27 41–43] and race/ethnicity.[29 30 41–43] For instance, one study found an increase in intention to not use e-cigarettes in the future among female adolescents,[42] while another recorded a higher initiation of e-cigarette use among female students after the interventions.[27] Evidence suggested that younger youth may be less responsive to the vaping prevention interventions. The only study reporting on socioeconomic status did not find differences between groups regarding the impact of the policy on ever-use of e-cigarettes.

DISCUSSION

This rapid review provided current evidence on effective policies and non-policy interventions to prevent youth vaping behaviours, taking into account the level of intrusiveness to individual autonomy and equity considerations. Given the multiple, complex factors behind the high prevalence of vaping among young adults (aged 18–24 years) including the co-use with cannabis and tobacco products and difficulties in quitting,[45] curbing youth vaping initiation at earlier ages is critical.

A promising result from this review is that most interventions recorded positive changes in the primary outcomes studied. For instance, the reduction of ever-use and/or initiation was achieved through interventions such as comprehensive indoor air laws[38] and peer-led prevention campaigns in school settings.[28] Similarly, the

Table 1 Summary of main characteristics of the 20 included papers

Characteristic	Categories	Number (%)*	References
Study design†	Experimental and quasiexperimental studies	9 (45%)	26 27 29 32 36 39 40 42 44
	Cohort studies	2 (10%)	25 41
	Cross-sectional studies	4 (20%)	30 31 34 43
	Not specified	5 (25%)	28 33 35 37 38
Country	Canada	1 (5%)	27
	Wales	1 (5%)	43
	South Korea	1 (5%)	31
	USA	17 (85%)	25 26 28–30 32–42 44
Intervention type	Non-policy	13 (65%)	26–29 32 35–37 39–42 44
	Policy	7 (35%)	25 30 31 33 34 38 43
Primary outcomes‡	Ever use of vaping products§	6 (30%)	25 30 33 38 39 43
	Initiation of vaping	3 (15%)	25 27 41
	Susceptibility to vaping	8 (40%)	26 28 29 32 34 39 40 42
	Beliefs and perceptions on harms, risks and social norms	7 (35%)	26 28 34 36 40 42 44
	Attitudes and behaviours	4 (20%)	28 34 36 42
	Knowledge	2 (10%)	26 37
	Reactions to the interventions	1 (5%)	29
	Perceptions of the effectiveness of the interventions	4 (20%)	28 31 35 36
Level of intrusiveness of the interventions¶**	Eliminate choice	5 (25%)	25 30 34 38 43
	Restrict choice	1 (5%)	43
	Guide choices through disincentives	1 (5%)	38
	Guide choices through incentives	–	–
	Guide choices by changing default policy	4 (20%)	29 31 33 43
	Enable choice	2 (10%)	39 40
	Provide information	9 (45%)	26–28 32 35–37 42 44
	Do nothing or simply monitor the current situation	1 (5%)	41
	Reorient government action	1 (5%)	43
Quality appraisal††	Strong	4 (20%)	25–28
	Moderate	5 (25%)	29–33
	Weak	11 (55%)	34–44

*All percentages calculated with 20 articles in the denominator.
†Study design as informed by authors.
‡Some papers included multiple outcomes.
§Past-month e-cigarette use was used as a proxy of ever e-cigarette use.
¶The level of intrusiveness of interventions was based on the *PLACE Research Lab Intervention Ladder Policy Analysis Framework*[21] (modified version of the *Nuffield Council on Bioethics intervention Ladder*[22]).
**Some papers reported on multiple interventions, and therefore, they were assigned different levels of intrusiveness.
††The Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies[24] was used to assess methodological quality of the included studies.

review indicated the impacts of specific interventions on different outcomes. An example is educational presentations at school that positively changed susceptibility,[32] beliefs and perceptions[26] and knowledge.[26 37] This disaggregated evidence may help policy-makers, public health professionals, school boards and other stakeholders to identify effective interventions that are aligned with the scope, mandate and resources of their organisation or government department.

There is no clear pattern that the more intrusive the interventions, the more effective they are. Overall, all nine levels of intrusiveness recorded interventions with a positive impact on at least one of the outcomes studied. The interventions that eliminate choice, which are the most intrusive, were effective in positively changing ever-use and/or initiation,[38] susceptibility,[34] beliefs and perceptions[34] and attitudes and behaviours.[34] Among the interventions that eliminate choice, we found that

Table 2 Impact of policies and non-policy interventions on outcomes according to the level of intrusiveness*

	Level of intrusiveness of the interventions	Ever-use and/or initiation	Susceptibility	Beliefs and perceptions on harms, risks and social norms	Attitudes and behaviours	Knowledge	Reactions to or perceptions of the intervention's effectiveness
Eliminate choice	Comprehensive clean indoor air laws; e-cigarette-inclusive smoke-free policies	+[38]	+[34]	+[34]	+[34]		
	Tobacco retail licensing legislation, T21	+[25 30]; 0/+[38]					
	Cross-border advertising ban	+[43]					
Restrict choice	Restrictions on nicotine strength	+[43]					
Guide choices through disincentives	Excise tax	0[38]					
Guide choices by changing default policy	Graphic health warning labels on tobacco products in general or only on e-cigarette products	+[43]					+[31]
	Municipal smoke-free ordinances	0[33]†					
	Household smoke-free policies	+[2 33]					
	Graphic messages tailored to the target population		0[29]				+[29]
Enable choice	School-based e-cigarette prevention programme with interactive modules	+[39]	+[39]‡				
	Tobacco-free or synthetic nicotine descriptors on e-cigarette products		0[40]	0[40]			

Continued

Table 2 Continued

	Level of intrusiveness of the interventions	Ever-use and/or initiation	Susceptibility	Beliefs and perceptions on harms, risks and social norms	Attitudes and behaviours	Knowledge	Reactions to or perceptions of the intervention's effectiveness
Provide information	Vaping prevention messages developed by public health organisations			+[44]			+[35]
	Gain or loss-framed text messages on vaping prevention			+[36]	+[36]		+[36]
	Educational presentation at school		–[26]; +[32]	+[26]		+[26 37]	
	Interactive education programme in school settings		+[42]	+[42]	+[42]		
	Various school-based prevention and cessation programmes for e-cigarettes	0/–[27]					
	Peer-led prevention campaigns in school settings	+[28]	+[28]	0[28]	+[28]		+[28]
Do nothing or simply monitor the current situation	Household rules allowing use of tobacco products inside home at baseline	0[41]					
	Health warning messages on cigarettes and electronic nicotine delivery systems at baseline	–[41]					
Reorient government action	Mandatory declaration of new products one semester in advance of their introduction in the market	+[43]					

*Positive (+) symbol: a positive change means the postintervention findings went in the direct, expected direction (eg, a reduction in ever e-cigarette use or an increase in perceptions of the health harms of e-cigarettes); negative (–) symbol: a negative means the postintervention findings may have produced harm or had unintended outcomes (eg, increase in susceptibility to vaping) and the number zero (0): a null change means no statistically significant differences between preintervention and postintervention findings. Policies are indicated in the bold.
†Past-month e-cigarette use was used as a proxy of ever use.
‡Differences borderline statistically significant.

Table 3 Summary of effectiveness of policies and non-policy interventions on outcomes, by the level of intrusiveness*†

Level of intrusiveness of the interventions	Ever-use and/or initiation	Susceptibility	Beliefs and perceptions on harms, risks and social norms	Attitudes and behaviours	Knowledge	Reactions to or perceptions of the intervention's effectiveness
Eliminate choice	Effective (four studies)	Effective (one study only)	Effective (one study only)	Effective (one study only)		
Restrict choice	Effective (one study only)					
Guide choices through disincentives	Not effective (one study only)					
Guide choices through incentives						
Guide choices by changing default policy	Effective (two studies)	Not effective (one study only)				Effective (two studies)
Enable choice	Effective (one study only)	Inconclusive (two studies)	Not effective (one study only)			
Provide information	Inconclusive (two studies)	Effective (four studies)	Effective (five studies)	Effective (three studies)	Effective (one study only)	Effective (three studies)
Do nothing or simply monitor the current situation	Inconclusive (one study only)					
Reorient government action	Effective (one study only)					

*Only levels with evidence from the included studies shown.
†No studies were found that had policies or interventions guiding choices through incentives.

government policies banning the sale of vaping products and devices to youth younger than 21 years are shown to be overall effective in preventing youth vaping behaviour,[25 30 38] which echoes findings from a previous systematic review.[16] Likewise, policies that prohibit people from using vaping products and devices in public or specific private indoor (eg, hospitals, childcare facilities and workplaces) and outdoor spaces (eg, bicycle parks, playgrounds and parking areas within school properties) are effective in many ways.[34 38] This is consistent with the literature indicating that these policies prevent youth from seeing others using vaping products and devices (which could otherwise contribute to the normalisation of vaping behaviour), reduce their exposure to e-cigarette secondhand aerosol and address their susceptibility to vaping in the future.[13]

The one study classified as guiding choices through disincentives found excise taxes had no impact on ever-use or initiation of vaping. This is different from other reviews that recorded a reduction in youth[16] and adult[46] vaping. Our findings suggest that excise taxes may need to be higher to increase prices enough to prevent youth from purchasing vaping products and devices. Although youth are price sensitive to vaping products and devices, it is currently unknown what level of e-cigarette tax rates can effectively reduce youth vaping initiation. Studies have advocated for federal regulations to better support statewide or province/territory-wide excise tax policies.[13 46] A good example of this approach is from Canada. In 2022, the Canadian federal government introduced a vaping taxation framework and invited provinces and territories to combine the existing federal excise taxes on vaping products with additional provincial or territorial taxes to strengthen the ability to curb the increasing vaping rates.[47 48] While most Canadian provinces have imposed additional taxes in the past 2 years, the impacts on youth vaping are still unknown. However, new evidence already suggests that this tax system may be undermined if a minimum price for nicotine is not implemented.[49]

Interventions providing information were also successful in all studied outcomes, equipping youth with knowledge, reducing their susceptibility and changing their beliefs and perceptions and attitudes and behaviours towards the health harms and social acceptability of vaping. However, their impact on reducing ever-use and/or initiation is inconclusive, suggesting that such interventions may fail to curb youth vaping ever-use and initiation. Coordinated efforts are required to help well-informed youth navigate peer pressures and social influences (eg, competitions for vaping trick performance and the creation of a collective social vaping identity)[13 50] and ultimately not use vaping devices and products.

Table 4 Equity-related findings by social factors according to the PROGRESS-Plus

Social factors	Ever-use and/or Initiation	Susceptibility	Knowledge	Impact
Gender/sex	A longitudinal study found that 17.1% of never-users at baseline started using electronic nicotine delivery systems (ENDS), among which 50.8% were male students.[41] The decreasing trend of ever e-cigarette use after the implementation of the Tobacco Products Directive was not associated with sex.[43] In schools that offered a theme week for vaping prevention, female students were more likely to initiate use of e-cigarettes after the intervention (OR=1.68, 95% CI 1.31 to 2.16).[27] In turn, in schools that implemented a cessation programme, the initiation of e-cigarette use was higher among male students than female students (OR=1.20, 95% CI 1.01 to 1.44).[27]	Compared with male students, the increase in intention to not use e-cigarettes in the future was greater among female students (1.67 higher change score).[42]	Not reported.	Evidence is mixed on the impacts of vaping prevention interventions on youth's biological sex.
Race/ethnicity	The T21 policy promoted a substantial decrease in lifetime e-cigarette use across all racial groups; however, the reductions were greater for American Indian/Alaska Native, Native Hawaiian/Pacific Islander, Asian American, African American, multiracial/unknown and Latinx relative to non-Latinx white ethnicity. This finding suggests the T21 policies can help address racial/ethnic inequities in lifetime e-cigarette use.[30] Among the 17.1% of youth who initiated ENDS use from baseline to subsequent survey years, 58.8% were non-Hispanic white ethnicity.[41] All ethnic groups experienced a reduction in ever e-cigarette use when the Tobacco Products Directive was introduced, with no statistically significant differences found between groups.[43]	Exposure to tailored graphic messages on health rewards, financial rewards, autonomy and social norms did not lead to statistically significant changes in susceptibility to vaping in the future among black and Latino adolescents.[29] Between pre-education and posteducation programme, the positive mean change in intention to not use e-cigarettes in the future was lower for non-Hispanic black ethnicity, non-Hispanic American Indians or Alaska Natives and Hispanics relative to non-Hispanic white ethnicity.[42]	Not reported.	Evidence is mixed on the impacts of preventive vaping interventions on youth race/ethnicity.
Socioeconomic groups	There were no statistically significant differences between low and high socioeconomic groups in the declining trend of ever e-cigarette use after the implementation of the Tobacco Products Directive.[43]	Not reported.	Not reported.	Evidence from one study indicates preventive vaping interventions had no differential impacts on socioeconomic groups.

Continued

Table 4 Continued

Social factors	Ever-use and/or Initiation	Susceptibility	Knowledge	Impact
Age	Among those who had never used ENDS at baseline, 17.1% of them started using the vaping devices, among which 61.7% were aged 12–14 years.[41] The risk of ENDS initiation was more than two times higher among adolescents aged 12–14 years relative to adolescents aged 15–17 years.[41] After the implementation of the Tobacco Products Directive, no statistically significant differences were recorded between ages in the decline in ever-cigarette use.[43]	Although there was a reduction in intention to try e-cigarettes among both high school and middle school students after the intervention, the intention was 1.5 times higher among middle school students than high school students.[26] From pretest to post-test, the mean change in intention to not use e-cigarettes in the future did not vary across ages.[42]	A combined analysis of users and non-users of e-cigarettes found that the educational intervention led to a statistically significant gain in knowledge on health and social risks of vaping with a higher increase among 11th and 12th graders compared with 9th and 10th graders.[37] Findings combining users and non-users of e-cigarettes showed that, compared with high school students, postintervention knowledge was 21% lower among middle school students and 25% of those students were less likely to believe in the health risks of e-cigarettes.[26]	The evidence indicates that vaping prevention interventions may be less effective among younger youths.

PROGRESS-Plus framework, Place of residence, Race/ethnicity/culture/language, Occupation,Gender/sex, Religion, Education, Socioeconomic status, Social capital, and additional context-specific factors.

With respect to equity-related findings, our review suggested that younger youth may not respond as expected to interventions. Given evidence showing early onset of vaping,[51] educational interventions should be age-appropriately tailored to younger youth to address positive attitudes towards vaping as well as poor knowledge and misperceptions of low risks of vaping, while not increasing children's curiosity about and intention to experiment with vaping. Stricter regulations to eliminate unnecessary exposure to vaping in public spaces and marketing strategies that disguise the design of vaping products and devices and create social media advertising campaigns for children are urgently needed.[13 52]

Recommendations for action

Based on the evidence gathered and assessed in the rapid review and considering health promotion principles and the current public debate and policy landscape on vaping, table 5 summarises key recommendations to support policy-makers, public health researchers, school administrators and health practitioners to develop and implement their own interventions and advocate for change. While recommendations are presented by the level of intrusiveness, a comprehensive multilevel approach would be most effective in reaching a wider group of youth. Integrating multiple strategies into a more holistic approach may be more successful for tackling different but interrelated factors (eg, exposure to vaping in public spaces and access to health warning messages) that contribute to youth vaping behaviours. For instance, better results may be achieved if schools implement a combined set of strategies: in addition to smoke-free policies on the school grounds (eliminate choice), vaping prevention programmes delivered by students themselves or in partnership with health services can provide students with skills (enable choice) and knowledge (provide information) to make informed decisions on vaping; together, these may be more effective for curbing youth vaping initiation. While the elimination of choices deters vaping on school grounds, the strategies that enable choice and provide information equip the students to navigate through other settings and contexts where vaping is also present (eg, recreational facilities, shopping malls and social media).

Strengths and limitations

This rapid review represents one of the first literature reviews identifying both effective policy and non-policy interventions to prevent the initiation of vaping behaviour among youth (aged 6–18 years) who have never used vaping devices or who have experimentally vaped. To the best of our knowledge, this review is also innovative for analysing the interventions in light of their levels of intrusiveness. Consistent with the quick and practice-focused nature of rapid reviews,[17] the search was limited to two databases and used a 5-year date limiter (2019–2023). However, the search strategy was comprehensive, using language related to only three broad concepts (age, vaping and prevention) to be more inclusive and capture a large number of studies. The date restriction was deemed appropriate to address the research question based on the rapidly evolving field of youth vaping. Notably, most of the included studies, while targeting youth in general, collected data on vaping behaviours and provided disaggregated findings for the population of interest. Given that policies are applied to the population in general, studies reporting on policies were included, which is a strength of this rapid review.

Only a very few systematic reviews or meta-analyses were found,[53] which is indicative of the incipient, but growing, literature reporting separate findings for youth who have never vaped or who have experimentally vaped. Due to the heterogeneity of study designs and measures used in the included studies, analysis and comparisons were limited. This precluded us from performing a meta-analysis and creating a forest plot to summarise the effect sizes. Country-specific contextual factors should be considered when examining the review findings, as 85% of the included studies were conducted in the USA. The robustness of the findings is difficult to determine, given that 55% of the included studies were rated as being of weak methodological quality. With the low internal validity, the effectiveness of the interventions as reported by the included studies may have been overestimated. None of the included studies' interventions were classified under the *guide choices through incentives* level. Caution is needed in the interpretation of findings related to the outcomes and to the levels of intrusiveness of interventions when there was only one study. For example, comparisons of the effectiveness for the *restrict choice*, *guide choices through disincentives* and *reorient government action* levels were not possible, given that only one study was listed under each of those levels. Due to the nature and scope of most non-policy interventions reported in the included studies, they only measured short-term effects.

While all included studies collected demographics before the intervention, most of them used statistical techniques to create models adjusting for demographic variables. This resulted in few included studies providing the differential impacts of the interventions on diverse population groups. In particular, measuring how children from different socioeconomic backgrounds responded to the interventions was rarely reported. Missing from the included studies were the focus and analysis of other important social factors that may influence the effectiveness of preventive interventions on youth vaping behaviours, such as gender (ie, sociocultural attributes to sex), place of residence (urban–rural spectrum) and religion.

Finally, the use of the *PLACE Research Lab Intervention Ladder Policy Analysis Framework*[21] was a strength, as it allowed for a contextually sensitive interpretation of the effectiveness of interventions. From a population health perspective, this is particularly critical for intervention design and planning, as some interventions may reduce

Table 5 Recommendations based on the literature review findings

Level of intrusiveness of the interventions	Recommendations
Eliminate choice	► Define a civil penalty structure for youth who violate the laws, providing alternative penalties to fines. This would reduce the chances of creating adverse consequences among those youth who already experience a disproportionate burden of social disadvantages. ► Enforce and apply monetary fines for international vendors involved in illegal sale of vaping products to youth. This may be a challenge to address considering the loopholes in government regulations around online sales to youth. ► Eliminate cross-border advertising to reduce exposure to vaping products and devices and prohibit the promotion of them in an appealing way for young people—even though it requires coordinated efforts between countries. ► Outlaw power wall displays of vaping products and devices in retail stores, as well as ban sales of these products to youth.
Restrict choice	► Limit nicotine strength to lower levels. ► Restrict marketing of vaping products and devices as smoking cessation services (ie, harm reduction promotion despite the limited evidence on the long-term safety risks of vaping). ► Develop regulatory strategies to restrict packaging design. This may have the potential to reduce vaping appeal and desirability, particularly for younger youth (eg, ages 12–14) who are more likely to be drawn to the varying shapes and sizes of vaping products and devices. ► Implement regulations on the current aggressive advertising techniques, including in the social media landscape.
Guide choices by changing the default policy	► Develop graphic warning labels on the packaging of vaping products and devices. ► Encourage the adoption of household smoke-free policies. ► Disseminate messages on health or financial rewards as they are well received by youth.
Enable choice	► Use interactive, short modules each covering a specific topic (eg, marketing strategies, flavours) in school-based vaping prevention programmes. The modules should be embedded in a user-friendly online portal, be collaboratively delivered by (eg, physical education) teachers and student-peer leaders, or follow physical activities that are based on the movement-oriented games in the modules. ► Prefer peer-led vaping prevention interventions on refusal skills over those led by experts. ► Deliver effective educational campaigns and programmes to increase youth awareness. This has the potential to address the current uncertainty and misperceptions about the source of nicotine in e-cigarettes and the meaning of tobacco-free nicotine or synthetic descriptors. Such strategies are even more critical when regulations are not yet in place for the marketing and selling of vaping products that still cause lifelong chemical dependence. ► Through educational programmes, equip youth with knowledge and skills on how to make the best, informed decisions for themselves. This should include learning about how to identify targeted marketing and advertising strategies (eg, sleek designs, fruity flavours) used by the vaping industry. ► Use educational strategies to provide training (via role-playing, virtual reality games, etc) for youth to develop lifelong refusal, resistance and assertiveness skills and navigate peer pressure and overcome social influences. ► Create a culture where non-vaping becomes synonymous with ‘being cool’ and ‘leading a healthy lifestyle’. This may help deconstruct the current positive image associated with vaping.

Continued

Table 5 Continued

Level of intrusiveness of the interventions	Recommendations
Provide information	► Deliver vaping prevention messages (in print, static web or video format) tailored to the youth. Through those messages, public health organisations have successfully reached youth and changed their perceptions and beliefs. Messages are more effective when they speak of addictions, brain and lung damage, death risks, harmful water vapour, or include the nicotine chemical symbol. ► Use a variety of platforms, including television and social media, to improve the dissemination of educational campaigns on the vaping risks to health. ► Through educational campaigns, provide information on the environmental risks posed by vaping products and devices, as well as the health risks of exposure to secondhand aerosol from vaping. Such strategies may be effective considering youth's sensitivity to environmental issues and unintended health consequences of exposure to vaping. ► Send brief text messages that use loss-framed messaging (ie, highlighting the negative consequences of vaping) to smartphones. ► Deliver educational programmes in school settings. Regardless of the format or who delivered the interventions, they support preventing youth vaping behaviours. ► Avoid single vaping prevention events in school settings. They have no impact on preventing youth vaping and may unintentionally increase curiosity about vaping products and devices. ► In school settings, consider implementing vaping prevention programmes with multiple sessions more than once a year to better respond to the evolving vaping landscape. ► Develop partnerships between schools and public health organisations, antivaping advocacy groups and other municipal and provincial departments concerned with vaping. Given schools' limited capacity, time and resources, such partnerships can bring know-how and support the implementation and evaluation of evidence-based vaping prevention programmes. ► In school-based interventions, use vaping prevention resources created by public health organisations (eg, hanging posters in restrooms that mention the marketing strategies used by the vaping industry). ► Ensure vaping prevention programmes are up to date with information on the latest products introduced in the market. Frequent adaptations and revisions of the resources are needed to reflect the most recent changes in the rapidly evolving vaping world. ► Keep vaping prevention programmes free of cost. This increases accessibility and is more inclusive and equitable.
Do nothing or simply monitor the current situation	► Ensure health warnings are revised periodically as their preventive effects may wear off over time. ► Encourage families to keep the household rules on youth vaping behaviours. This may have a stronger impact on youth than community norms.
Reorient government action	► Ensure policies require new vaping products and devices to be declared 6 months in advance of their introduction to the market. This provides a more regulated context in which manufacturers are more limited in their ability to preserve and reignite youth's interests. This mandatory time frame to introduce new products in the market gives governments more time to review and approve them and may support response and mitigation strategies to protect youth.

personal autonomy while seeking to achieve collective benefits.

CONCLUSIONS

This rapid review identified and assessed what interventions (as reported in the literature) are effective to prevent initiation of vaping behaviour among youth aged 6–18 years. Overall, a range of interventions at different levels of intrusiveness and targeting varied outcomes showed promising results. While an intervention may promote positive changes, combining multiple interventions for different outcomes (eg, beliefs and susceptibility) from different levels of intrusiveness (eg, eliminate choice and provide information) may be most effective for encompassing a myriad of interrelated factors that contribute to youth vaping (eg, price, desirability, access, exposure and misperceptions), as observed elsewhere with a young adult population.[45] Adoption of simultaneous, varied types of interventions may be key in preventing youth vaping behaviours when other interventions may start to fail or their implementation is inconsistent (eg, non-compliance by retailers on age restrictions for purchasing vaping products and devices). Future research is needed to determine ease of replication, transferability and scalability of the interventions to different contexts. Research on preventive interventions should aim to measure the medium and long-term effects of policies and non-policy interventions, their cost-effectiveness, as well as their differential impacts on disadvantaged subpopulations (eg, socioeconomic groups) to support decision-makers to adopt the intervention(s) that can better respond to their contextual needs.

X Candace I J Nykiforuk @nykiforuk_c

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ORCID iDs
Ana Paula Belon http://orcid.org/0000-0002-4600-3202
Candace I J Nykiforuk http://orcid.org/0000-0002-1017-5475

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