

BMJ Open School-based preventive interventions targeting e-cigarette use among adolescents: a systematic review protocol

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ABSTRACT

Introduction Electronic cigarette (e-cigarette) use has drastically increased in recent years, particularly among adolescents. This poses several acute and chronic harms to young people, including poisonings, burns, serious lung injury and—where nicotine e-liquid is used—the potential to impact healthy brain development and precipitate future nicotine addiction. School-based prevention programmes have the potential to address this growing public health concern by reaching large numbers of young people during a critical period for intervention; however, the efficacy of such interventions has not been systematically explored. This systematic review aims to determine the existence and efficacy of school-based preventive interventions targeting e-cigarette use.

Methods and analysis A systematic search of MEDLINE, Embase, PsycINFO, Scopus, CINAHL, Cochrane Database of Systematic Reviews and international clinical trials registries will be conducted from 2000 to April 2022 to identify eligible studies (randomised controlled trials, cluster randomised controlled trials and quasiexperimental studies) evaluating school-based interventions to prevent e-cigarette use among adolescents. Two reviewers will independently screen title, abstract and full text of all studies for eligibility. Both reviewers will independently extract the data and assess the risk of bias. Any discrepancies will be resolved by a third reviewer. Results will be summarised in a narrative synthesis and data will be meta-analysed if appropriate. Heterogeneity in findings will be assessed narratively, and using the I^2 statistic (where meta-analysis is feasible), meta-regression will be used to explore potential factors associated with programme efficacy, where data permit.

Ethics and dissemination This research is conducted on published work and does not require ethics approval. The findings will be published in a peer-reviewed journal and used to guide the development of new school-based e-cigarette preventive interventions.

Trial registration number CRD42022323352.

INTRODUCTION

Electronic cigarettes (e-cigarettes), commonly known as vapes, are a diverse range of electronic or battery powered devices that heat liquid, turning it into an aerosol vapour for inhalation.¹ These typically contain agents to

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The proposed systematic review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and will be the first to comprehensively summarise and evaluate the efficacy of school-based preventive interventions addressing electronic cigarette use among adolescents.
- ⇒ The screening of titles, abstracts and full-text, and risk of bias and quality assessment will be independently performed by two reviewers, with a third resolving any disagreements. This minimises the potential for reviewer bias.
- ⇒ No language restrictions will be applied and therefore there is no risk of language bias.
- ⇒ The heterogeneity of interventions may make direct comparison between studies difficult.

create flavours, such as bubble gum and fairy floss, and can be brightly coloured, making them attractive to children and adolescents.^{2,3} E-cigarettes also often contain nicotine, which adolescents are particularly sensitive to, along with propylene glycol (a solvent carrier which is often used in antifreeze and is toxic in high concentrations) and other chemicals which are potentially harmful when inhaled.⁴ Additionally, contaminants including metals, volatile organic compounds (such as chemicals used in paint thinner and nail polish remover), phthalates (a chemical to make plastic more durable), pesticides and tobacco-specific nitrosamines (a carcinogenic chemical) have also been found.^{2,5–7} There are also growing reports of illicit substances (most commonly cannabis derivatives) being added to e-liquids. Although young people commonly perceive e-cigarettes as a safer alternative to traditional tobacco cigarettes,⁸ recent evidence highlights that e-cigarettes can cause an array of health problems, such as respiratory disease (e-cigarette or vaping use associated lung injury—EVALI), seizures,

poisoning, injuries, and can lead to dependence of nicotine as well as other drugs of addiction (eg, cannabis).^{4 9} In fact, evidence has shown that more than half of adolescent e-cigarette users experience some level of nicotine dependence.¹⁰ E-cigarettes have also been linked with adverse mental health outcomes among adolescents, including depression and suicidal ideation,¹¹ and many of the longer-term consequences of early exposure to e-cigarettes remain unknown.²

Despite the potential harms, since their invention in 2003, e-cigarettes have steadily increased in popularity, particularly among adolescents,¹² with their use now considered a global public health concern.^{13 14} In countries where e-cigarette use emerged early, such as the USA and Canada, rapid increases in use were followed by somewhat of a stabilisation; however, rates remain high, with around half of American, and a third of Canadian high school students having tried e-cigarettes in 2019.¹⁵ Similar rates have been reported in Europe (eg, 52% of French 8–19-year olds report ever having used an e-cigarette),⁴ and trends indicate rapid increases across the continent. In Pacific nations, where e-cigarette uptake occurred more recently, use continues to rise rapidly.^{16 17} In Australia, in 2017, approximately 14% of 12–17-year olds had used an e-cigarette, and of these, 32% had done so in the past month.¹⁸ In New Zealand, regular vaping among Year 10 students has increased rapidly from 12% in 2019 to 20% in 2021, largely driven by increases in daily vaping.¹⁶ Effective public health strategies are urgently needed to address this global health issue.

It is well established that prevention initiatives can be the most cost-effective and effective in addressing public health problems, including substance use, thereby making prevention a key priority across all domains of health.^{19 20} While there is some evidence that policy-level prevention initiatives, such as laws to reduce access, use and supply, taxation and advertising bans, can reduce substance use, with emerging evidence for impact on e-cigarette use, these initiatives also take some time to be introduced, are not always feasible and are often costly.^{20–22} Further, as seen with other substances, it is unlikely that we will be able to eliminate e-cigarette use completely, and there will remain a need to educate and build resistance skills, particularly among young people, to prevent, delay or reduce the harms from use.^{22–24} School is an ideal setting for such efforts for several reasons. First, it is already a key place for guiding and shaping behaviour.²⁵ Schools provide an opportunity to reach large numbers of young people before, and at the time, they are typically first exposed to substance use.¹⁸ Adolescents typically spend a substantial proportion of their lives at schools, with their social lives tending to revolve around the school environment.²⁶ Finally, within countries like Australia, England and much of Eastern Europe, substance use education is a mandatory component of the health education curriculum.²⁷

Although programme efficacy varies, overall, prior systematic reviews have revealed that school-based

prevention approaches can be effective at improving tobacco, alcohol and/or other drug use outcomes among adolescents,^{28 29} with some interventions demonstrating lasting effects into early adulthood.³⁰ When considering school-based preventive interventions targeting tobacco smoking in particular, the most effective programmes incorporate a social competence and social influence approach to prevention,²⁸ with similar findings for broader substance use prevention programmes.³¹ Recently, several non-systematic reviews of the literature have examined prevention programmes targeting e-cigarette use, both within schools and more broadly.^{32 33} The school-based interventions have tended to focus on delivering education about e-cigarettes and the influence of targeted advertising, with some deemed successful in altering adolescents' perceptions and behaviour around e-cigarettes, despite not always involving an experimental design.^{32 33} A 2019 Canadian report included a search of the academic literature for preventive e-cigarette interventions and found nearly no studies to report on effectiveness.³⁴ However, the number of interventions has steadily increased in recent years, highlighting the need for a more rigorous review of the literature. To our knowledge, no study has systematically examined the efficacy of school-based preventive interventions for e-cigarette use. Accordingly, this review aims to:

1. Identify all available school-based preventive interventions that have been rigorously evaluated and summarise their key components and characteristics.
2. Evaluate the efficacy of school-based preventive interventions in preventing e-cigarette use among adolescents.

Methods and analysis

This systematic review has been prospectively registered with PROSPERO 2022 CRD42022323352 (available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42022323352) and will conform with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) guidelines³⁵ (see online supplemental appendix 1).

Eligibility criteria

Studies eligible for inclusion in the proposed systematic review must target adolescents aged between 11 and 18 years of age at study intake (ie, those of secondary school age) and evaluate an intervention targeting the prevention of e-cigarette use. Interventions must be conducted in a secondary school setting, however school-based interventions incorporating additional components (such as family-based or community-based elements) will also be eligible. Eligible study designs will include randomised controlled trials, cluster randomised controlled trials and quasiexperimental studies, as these designs provide the highest quality evidence. These studies will compare the intervention group to a comparison group that received no intervention, education as usual or an alternate intervention. Programmes may be universal (ie, delivered to

all students in the intervention condition, regardless of their level of risk) or selective (ie, delivered to higher-risk students in the intervention condition) in nature. Interventions addressing other risk behaviours in addition to e-cigarette use (eg, tobacco use or illicit drug use) will be eligible for inclusion. Studies will be excluded on the basis of not targeting adolescents; not directly addressing e-cigarette use in the intervention; having no school-based components; being a non-experimental design or having no control group. To ensure we provide a full assessment of the literature, studies that examine e-cigarette prevention but do not meet our inclusion criteria will be summarised briefly in an appendix.

Search strategy

A database search strategy will be developed in consultation with a librarian. Databases, including MEDLINE (Ovid), Embase (Ovid), PsycINFO (Ovid), Scopus, CINAHL, the Cochrane Database of Systematic Reviews (Ovid) and international clinical trial registries via the Cochrane Central Register of Controlled Trials (Ovid), will be searched (an example search strategy is provided in online supplemental appendix 2). The search will be limited to human studies published between 2000 (to slightly precede the advent of e-cigarettes in 2003 and thus ensure full capture of studies) and 2022. No language restrictions will be enforced. All papers identified in the search strategy will be exported into a citation management system (EndNote) and uploaded to the Covidence online software programme for deduplication and screening. The reference lists of eligible papers will be reviewed to identify other relevant studies.

Data extraction and screening

The titles and abstracts of identified articles will be independently screened against the eligibility criteria by two reviewers. Two reviewers will assess full-text copies of potentially relevant papers for eligibility. Any disagreement will be resolved by a third reviewer. Data extraction will occur using a standardised extraction form, which will be piloted a priori by the two reviewers to ensure that it adequately captures trial data. Data will be extracted by one reviewer, independently confirmed by a second reviewer and will include:

- Publication details (study authors, year published, funding).
- Study characteristics (date of study, duration of follow-up, design, country, sample size, attrition, intervention time).
- Participant characteristics (eg, age, gender, ethnicity, socioeconomic status, baseline substance use).
- Intervention characteristics (delivery method, programme duration, frequency of delivery, theoretical basis, content and components).
- Primary and secondary outcomes of interest across all time points.
- Measurement tools employed (eg, validated scales, objective measures).

- Details of the comparison group.
- Data to assess the risk of bias, including details of the random sequence generation and randomisation process, bias due to deviations from the intended interventions, bias due to missing outcome data, bias in measurement of the outcome, bias in the selection of the reported result and any other risks of bias.³⁶
- Process data to determine the degree to which an intervention was implemented as intended (eg, attendance rates, fidelity, dosage, engagement).

Where necessary, the corresponding author of included studies will be contacted by email to obtain any required data not presented in the published paper.

Outcomes

The primary outcome of interest will be the prevention of e-cigarette use at longest follow-up, expressed as a dichotomous outcome whereby the N (or percentage) of participants in the intervention group reporting e-cigarette use is compared with the N (or percentage) of participants in the control group reporting e-cigarette use. Where possible, we will extract raw Ns, but where not available in the publication or via author contact, we will extract effect sizes and their confidence intervals (eg, ORs, risk ratios, HRs and so on).

The secondary outcomes will include, but are not limited to: the reduction or cessation of e-cigarette use among adolescents already reporting e-cigarette use at baseline; knowledge, attitudes, future intentions and self-efficacy to not engage in e-cigarette use; perceptions of harms of e-cigarettes and tobacco cigarettes and the prevention, reduction or cessation of tobacco cigarette use; mental health outcomes (eg, anxiety, depression, suicide, or self-harm); other substance use and intervention characteristics and engagement strategies associated with effectiveness and intervention uptake.

Data for outcomes at all follow-up time points will be extracted and synthesised for all eligible studies. It is anticipated that there may be multiple measures of e-cigarette use both across, and within studies, for example, lifetime e-cigarette use and current e-cigarette use. In these instances, all types and units of measurement of the outcomes will be extracted.

Patient and public involvement

None.

Risk of bias

Risk of bias of all included studies will be independently assessed by two reviewers using the Cochrane Collaboration's tool for assessing risk of bias (RoB 2) for all randomised studies³⁷ and the Risk of Bias in Non-randomised Studies of Interventions (ROBINS-I) for all non-randomised studies.³⁸ A third reviewer will resolve any discrepancies. We will assess certainty of primary outcomes using the Cochrane Grading of Recommendations Assessment, Development and Evaluation (GRADE) Framework.³⁹



Analysis

Where data permit, we will synthesise primary and secondary outcomes using random effects meta-analysis in Stata V.17.0. Dichotomous outcomes (such as % reporting onset of e-cigarette use at follow-up) will be expressed as ORs and 95% CI and continuous outcomes (such as difference in number of e-cigarette sessions per day) will be expressed as standardised mean differences and 95% CI. Heterogeneity will be assessed using the I^2 statistic and described as small, moderate or large based on values of 25%, 50% and 75%, respectively. Where data permit, we will conduct exploratory meta-regression to identify potential factors associated with programme efficacy.

Where there are insufficient data to summarise using meta-analysis, a narrative synthesis will be conducted, based on the Synthesis without Meta-Analysis guidelines.⁴⁰ Synthesis of the following study aspects may be conducted: delivery method (eg, online, in-person, hybrid); intervention duration, frequency, length and adherence; prevention style (ie, universal or selective); theoretical underpinning of intervention; portion of programme dedicated to e-cigarette use (eg, entire programme, supplemental section, specific module); sample characteristics (eg, age, gender, socioeconomic status); evaluation process (eg, randomised controlled trial); primary and secondary outcomes. Quality of the body of evidence across included RCTs for the primary and secondary outcomes will be assessed using the GRADE framework.

DISCUSSION

The proposed systematic review will be the first to comprehensively summarise and evaluate the efficacy of school-based preventive interventions addressing e-cigarette use among adolescents. This protocol adheres to the PRISMA-P guidelines and the full review will be reported in line with the PRISMA guidelines while employing best practice methodologies.^{39 40}

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Contributors LAG conceptualised the study, with assistance from KEC and NCN. The search strategy was developed by TA in consultation with LAG and A-LR. LAG and A-LR led the write-up of the manuscript. All authors critically revised and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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