

Vaping – Role as a gateway to smoking: evidence briefing

Introduction

This briefing presents our understanding of the role played by vaping in smoking initiation based on the examination of existing literature and engagement work with national and international experts.

Background

The expression “gateway effect” is commonly used to describe the hypothesis that vaping products can act as a stepping stone to tobacco smoking. It is assumed this would be mostly the result of exposure to nicotine and consequent addiction to it, but also determined by similar hand-to-mouth behaviours.

Methodology

This evidence briefing is based on a search and analysis of scholarly research on vaping as a gateway to tobacco smoking carried out between December 2022 and November 2023.

The search was conducted on a number of search engines: KandE (a Scottish Government resource covering several databases), Google Scholar, PubMed and ScienceDirect. It included the following terms: “ENDS”, “e-cigarettes”, “vapes”, “vaping”, “gateway”, “gateway effect”, “tobacco smoking”, “cigarettes”, “young people”, “children”, “adolescents”, “teenagers”, “addiction”.

Thirty-seven papers/reports were selected and reviewed (opinion pieces and editorials were excluded). Of these, eight were systematic reviews and/or meta-analyses, hence have been prioritised and represent the core sources used to write this briefing. No critical appraisal of the evidence they examined was undertaken.

Furthermore, Scottish Government officials have engaged with colleagues from Public Health Scotland, academics and international experts to discuss ongoing research and upcoming publications on the gateway effect to adopt a balanced approach on a highly debated topic.

In this briefing we make reference to “vaping products” to describe both nicotine and non-nicotine devices used to inhale an aerosol. The sources analysed here adopt different terms and definitions. For accuracy and in order to preserve the original meaning, the terminology chosen by the authors of each review has been retained when summarising their findings.

Key findings

The systematic reviews and meta-analyses on the gateway effect examined for this briefing have consistently found an association between vaping and subsequent smoking. However, the quality of the available evidence has often been questioned due to its heterogeneity (e.g. study design, terminology, different types of vaping devices on the market at the time of the research) and robustness (e.g. small sample size, self-reported measures, inadequate adjustment for potential confounders).

The examined sources show that:

- Despite the above-mentioned limitations, there is agreement in five out of eight reviews that vaping may act as a gateway to smoking (with the most recent review establishing 3 times higher odds of initiating tobacco cigarette smoking for vapers). This assessment is based on the consistency of results across studies.
- Three reviews out of eight conclude that, although there is a strong association between vaping and subsequent smoking, it is impossible to establish causality and determine whether the relationship is due to a gateway effect. Two of these reviews also suggest that the association may be due to the common liability hypothesis (i.e. the same genetic or environmental factors that increase the likelihood of someone vaping also increase the likelihood of someone smoking).

All the reviews highlight the need for more research, given studies’ limitations and the ever-evolving nature of vaping products. New primary studies underway and a systematic review by Cochrane due to be published in 2024 will add to our current knowledge of the gateway effect.

Policy implications

Despite the limitations highlighted in the systematic reviews and meta-analyses examined for this briefing, the Scottish Government has taken into account the strong association between vaping and initiation of smoking, and adopted an

approach aimed to protect all non-smokers (and especially the youngest) from the risk of becoming addicted to nicotine.

This is a developing area of research and it is likely to take some years until long-term trends can be observed. Even then, it may not be possible to establish causality. The Scottish Government will continue to monitor vaping and smoking statistics, and consider any new evidence encountered on the gateway effect.

Annex – Analysis of the existing evidence

Studies concluding that vaping may act as a gateway to smoking

There is agreement in the majority of the reviews examined for this briefing (five out of eight) that vaping may act as a gateway to smoking, despite the limitations of the available studies and a need for more research:

- The National Centre for Epidemiology and Population Health conducted a [systematic review of global evidence for the Australian Department of Health](#) which was published in 2022. This concluded that:
 - there is **strong** evidence from 17 observational studies that never smokers who use e-cigarettes are on average around three times as likely than those who do not use e-cigarettes to initiate cigarette smoking (aOR¹: 3.19; 95% CI 2.44 – 4.16); and
 - there is **strong** evidence from 8 observational studies that non-smokers who use e-cigarettes are around three times as likely as those who do not use e-cigarettes to become current cigarette smokers (aOR: 3.14; 95% CI 1.93 – 5.11; I²=91%²).

While the studies examined in the review consistently observed an increased risk of smoking uptake with e-cigarette use, the magnitude of the risk varied substantially by study.

- The [Scientific Committee on Health, Environmental and Emerging Risks \(SCHEER\) review](#) for the European Commission, published in 2021, concluded that there is **moderate** evidence that e-cigarettes are a gateway to smoking for young people.

The reviewers highlighted a number of limitations in the studies examined:

- heterogeneity in terms of study design and methodology, sample size, age groups, measurements of experimental use and follow ups;
- geography of the studies, as they were mostly conducted in the US and other non-European Union countries, meaning different regulatory environment, population perspectives on vaping products and prevalence of smoking/vaping, which could impact the association between use of vaping products and subsequent use of tobacco products;
- type of vaping products on the market at the time of the studies, as these did not contain nicotine salts (which may pose a higher likelihood of developing addiction to nicotine as they increase its smoothness and reduce its bitterness).

¹ Adjusted odds ratio.

² Percentage of variation across studies that is due to heterogeneity rather than chance.

- An [Irish systematic review and meta-analysis](#), conducted by the Health Research Board and the Health Intelligence Unit and published in 2021, concluded that e-cigarette use was associated with commencement of tobacco cigarette smoking among teenagers in Europe and North America. In particular, the authors found:
 - 4 times higher odds of commencing tobacco cigarette smoking for teenagers who had ever used e-cigarettes at baseline (the odds ratio was marginally lower when only the studies rated as high-quality included in the review were analysed); and
 - a significant two-fold positive association between past-30-day e-cigarette use at baseline and subsequent cigarette smoking initiation at follow-up.

Despite some limitations identified in the studies (e.g. absence of biochemical verification of outcomes and measurements of experimental use), the authors declared **moderate** confidence that the true effect was probably close to the estimated effect for initiating smoking at follow-up for those who had ever used e-cigarettes at baseline.

- The National Academies of Sciences, Engineering and Medicine (NASEM) published a report on the [Public Health Consequences of E-cigarettes](#) in 2018. Regarding the gateway effect, this concluded that there is **substantial** evidence to suggest e-cigarette use increases the risk of ever using combustible tobacco cigarettes among youth and young adults.

The Committee's confidence in a possible causal link was based on the consistency of results across studies despite their heterogeneity (e.g. differences in research methods, length of follow up, definitions, locations, etc.).

While noting that ecological trends in e-cigarette use and smoking prevalence in youth didn't support this causality, and even suggested that vaping was associated with reduced smoking, the Committee highlighted how:

- the rate of reduction of smoking in US youth recorded in previous years had remained consistent since e-cigarettes became popular; and
 - that changes in prevalence from 2015 to 2016 among US high school students declined substantially for e-cigarettes but only marginally for combustible tobacco cigarettes.
- The Australia's national science agency, [Commonwealth Scientific and Industrial Research Organisation \(CSIRO\) published a review](#) on e-cigarettes, smoking and health in 2018. This concluded that there is evidence for a **strong** positive relationship between use of e-cigarettes and later cigarette smoking among youth, with consistent results in observational studies across different countries.

The use of e-cigarettes with higher concentrations of nicotine was observed to have a stronger association to later conventional cigarette use, although a positive association was found even when non-nicotine e-cigarettes were considered.

The authors identified a number of limitations in the studies examined, such as variations in measurements of use and follow up periods, small sample sizes, lack of data on retention rates and of adjustments for key confounders.

Studies concluding that it is impossible to establish causality between vaping and subsequent smoking

Three reviews out of eight concluded that, although there is a strong association between vaping and subsequent smoking, it is impossible to establish causality and determine whether this is due to a gateway effect:

- A [systematic review and meta-analysis conducted by scholars at the University of Bristol](#), published in 2020, concluded that there was a **strong association** in observational studies between e-cigarette use among young non-smokers (up to the age of 30) and subsequent cigarette smoking.

Results indicated e-cigarette users had four-and-a-half-fold higher odds of subsequently reporting being smokers compared to those who never used e-cigarettes. The pooled adjusted estimate indicated a weaker but still strong association (three-fold increased odds). The association was stronger in:

- studies including those under the age of 18 years than studies excluding them, suggesting that decision making for health-risk behaviours is influenced by peers, societal influences and parental monitoring; and
- studies based in the UK compared to those based in the US, possibly due to factors such as legislation, taxation, social norms and public opinions.

While estimates were consistently in the same direction of indicating a plausible causal pathway, the evidence was **limited** by the reliance on self-report measures of smoking history without biochemical verification, lack in all studies of negative controls (which would support the causality hypothesis) and failure in most studies to consider the nicotine content of e-liquids (making it impossible to establish whether addiction was the driving mechanism determining tobacco smoking). Hence, the authors concluded that the results **do not** provide strong evidence of a gateway effect.

- A [systematic review and meta-analysis, conducted by scholars at the University of Queensland \(Australia\)](#) and published in 2020, concluded that there is a **significant** longitudinal association between adolescent vaping and smoking initiation. According to the authors' meta-analysis, those who initiated vaping during adolescence had a 2.93 times higher odds of future smoking initiation.

However, the authors highlighted that the current evidence is **limited** by publication bias, high sample attrition and inadequate adjustment for potential confounders, and argued that pooled estimates from the examined studies are likely to overestimate the true effect of vaping on later smoking.

Given these limitations, the review concluded that it is unclear whether the relationship between vaping and subsequent smoking is causal (gateway effect) or is due to common liability (a propensity to substance use that could explain the combined risk of becoming both vaper and smoker).

- The [Public Health England evidence review](#) on e-cigarettes and heated tobacco products, published in 2018, concluded that in the UK never smokers who had tried e-cigarettes were **more likely** to try smoking subsequently than those who had never tried e-cigarettes.

Highlighted limitations in the studies examined by the reviewers pertained to measurements of use and impossibility to control for all relevant confounders. Given the impossibility to establish a causal link, the reviewers considered the common liability hypothesis as a more plausible explanation of the relationship between vaping and subsequent smoking.



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