Public Health England

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Vaping in England: an evidence update including mental health and pregnancy, March 2020

A report commissioned by Public Health England

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Contents

Conflict of interest statement

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All authors are members of the SPECTRUM consortium.

Acronyms and abbreviations

APS = Annual Population Survey

ASH = Action on Smoking and Health

ASH-A = ASH Smokefree Great Britain Adult survey

ASH-Y = ASH Smokefree Great Britain Youth survey

CES-D = Center for Epidemiological Studies − Depression

CI = Confidence Interval

CO = Carbon Monoxide expired air

COREQ = Consolidated Criteria for Reporting on Qualitative Research

CPD / CPW = Cigarettes Per Day / Cigarettes Per Week

DSM = Diagnostic and Statistical Manual of Mental Disorders

EVALI = E-cigarette, or vaping, product use associated lung injury

FDA = Food and Drug Administration (US)

FTND = Fagerstrom Test for Nicotine Dependence

ITC = The International Tobacco Control Policy Evaluation Project

IQR = Inter-Quartile Range

K6 = Kessler Screening Scale for Psychological Distress

MHC = Mental Health Condition

MHRA = Medicines and Healthcare products Regulatory Agency

NHIS = National Health Interview Survey

NICE = National Institute for Health and Care Excellence

NIDA = National Institute on Drug Abuse (US)

NNAL = 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol

NNK = 4-(methylnitrosamino)-1(3-pyridyl)-1-butanone

NOS = Newcastle Ottawa Scale

NRT = Nicotine Replacement Therapy

OPN = Opinions and Lifestyles Survey

OR = Odds Ratio

PATH = The Population Assessment of Tobacco and Health Study

PRAMS = Pregnancy Risk-Assessment Monitoring System

PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROSPERO = The International Prospective Register of Systematic Reviews

PTSD = Post-Traumatic Stress Disorder

RCT = Randomised Controlled Trial

RR = Relative Risk

SDD = Smoking Drinking and Drug use among young people in England (Survey)

SD = Standard Deviation

SMI = Serious Mental Illness

SPD = Serious Psychological Distress

STS = Smoking Toolkit Study

THC = Tetrahydrocannabinol

TPD = European Union Tobacco Products Directive

TRPR = Tobacco and Related Products Regulations 2016

Executive summary

1. Introduction

1.1 Aim of the report

This is the sixth report in a series of independent reports commissioned by Public Health England to summarise evidence on e-cigarettes to inform policies and regulations.

Despite reductions in smoking prevalence, smoking remains the biggest single cause of preventable death and disease and a leading cause of health inequalities. So, alternative nicotine delivery devices which are less harmful could play a crucial role in reducing this health burden.

This report presents updates on the prevalence of vaping among young people and adults and reviews literature on vaping among people with mental health conditions and pregnant women.

A comprehensive e-cigarette safety review will be the focus of a future report.

1.2 Terminology

We use the term 'vaping products' to describe e-cigarettes and refill containers (e-liquids).

We use the term 'vapers' to refer to people who regularly use vaping products and 'vaping' as the act of using a vaping product.

Our terms do not include cannabis vaping or the vaping of other illicit substances, which are not the subject of this report.

1.3 Current regulations

Non-nicotine containing vaping products fall under the General Product Safety Regulations 2005, enforced by local trading standards.

Nicotine-containing vaping products are regulated more stringently through the revised European Union Tobacco Products Directive (2014/40/EU) (TPD), translated into United Kingdom (UK) law through the Tobacco and Related Products Regulations 2016 (TRPR), which the government has committed to review by May 2021.

There are no medicinally licensed nicotine vaping products in the UK.

Selling vaping products to anyone under 18 is prohibited and so is buying vaping products for anyone under 18.

1.4 Recent developments

Nicotine vaping products have continued to evolve. The use of nicotine salt technology is becoming more popular.

Between 20 May 2016 (implementation of TRPR) and 9 January 2020, the Medicines and Healthcare products Regulatory Agency (MHRA) had received 84 reports of 245 adverse reactions believed to be associated with vaping products that contain nicotine through its Yellow Card Scheme. A report is not proof that the reaction was caused by a vaping product, just that the reporter suspected it might have been.

In the US, where there is a very different regulatory system for vaping products (including products used to vape cannabis), there was a spate of serious lung diseases and deaths that appeared to peak in late 2019. This outbreak seems to have been caused by people vaping the cannabis derivative tetrahydrocannabinol (THC) oil and vitamin E acetate.

There has been no similar lung disease outbreak in England, although the MHRA has received reports of 4 deaths through its Yellow Card Scheme where vaping was suspected to be implicated (2 before implementation of TRPR and 2 more recently). However, the connection with vaping products that contain nicotine has not yet been established. There is more information in the January 2020 MHRA Drug Safety Update. There are also 2 published serious cases of respiratory illness that have been linked to vaping.

Violations of the age of sale law for nicotine-containing vaping products (and for cigarettes) and the use of social media to promote vaping products are being reported. The Advertising Standards Authority (ASA) recently upheld some complaints where the marketing of vaping products had violated the UK Advertising Code.

Most mental health trusts in England allow vaping but there are inconsistencies in policy and practice. The report of the House of Commons Science and Technology Committee enquiry on e-cigarettes recommended that NHS England produce guidance on vaping in mental health trusts, which is still outstanding.

1.5 Implications

Since non-nicotine vaping products are less stringently regulated than nicotine-containing products, they may need to be reviewed alongside the forthcoming review of nicotine vaping regulations.

NHS England should issue guidance on vaping in mental health trusts to make sure there is consistency and equity across the NHS.

The spate of lung injuries and deaths in the US is not attributable to the regulated nicotine vaping products currently sold in England. But all suspected adverse reactions or suspected deaths need to be assessed.

The conclusions of our previous reports are still important messages for preventing harm. These can be broadly summarised as:

1. Vaping regulated nicotine products has a small fraction of the risks of smoking, but this does not mean it is safe.
2. Smokers should be encouraged to try regulated nicotine vaping products along with smoking cessation medications and behavioural support. This will greatly increase their chances of successfully stopping smoking.
3. People who have never smoked should be encouraged not to smoke and not to vape.
4. Vapers should be encouraged to use regulated nicotine products only and stop smoking completely.

2. Methods

We have used data from 6 nationally representative surveys to examine prevalence and characteristics of vaping in England. We have also screened the international academic literature for studies published between November 2018 and October 2019 that report vaping prevalence.

We have used data collected by NHS Digital from stop smoking services, data from the MHRA Yellow Card Scheme and data from peer-reviewed publications.

We have conducted 2 systematic reviews of the published academic literature that identify the evidence on vaping among people with a mental health condition and on vaping in pregnancy.

3. Vaping among young people

3.1 Main findings

Current vaping prevalence (weekly or less than weekly) among young people in England has remained reasonably steady with the best recent estimates putting it at 6% of 11- to 15-year-olds in 2018 and 5% of 11- to-18-year-olds in 2019.

Older children are more likely to vape. Current use among 11-year-olds was estimated at less than 1% in 2018, compared with 11% of 15-year-olds.

Current vaping is mainly concentrated in young people who have experience of smoking. Less than 1% of young people who have never smoked are current vapers.

No surveys reported much increase in vaping prevalence.

Current smoking prevalence (weekly or less than weekly) among 11- to 15-year-olds halved between 2009 (11%) and 2018 (5%) but has remained relatively steady since 2014.

Young people's perceptions of the relative harms of vaping compared with smoking are increasingly out of line with the evidence. The proportion of 11- to 18-year-olds who thought that vaping was less harmful than cigarettes declined from 68% in 2014 to 52% in 2019.

Just over a third of 11- to 15-year-olds thought it was OK to try vaping and just under a quarter thought it was OK to vape once a week.

Most young people who have tried vaping do so from curiosity.

Tank models, which are reusable and rechargeable kits that users can refill with liquid, remain the most popular vaping device type used by young people.

Recent UK surveys have not asked about the use of flavours among young people who vape.

Almost 60% of 11- to- 15-year-olds who vaped regularly (more than once a week) reported being given vaping products, mostly by friends. But many also reported buying vaping products from other people, shops and the internet.

Comparisons across countries are hampered by inconsistent questions and survey methods. One survey that compared vaping among 16- to 19-year-olds from 2017

to 2018 using consistent methods found lower levels of vaping in England compared to Canada and the US.

3.2 Implications

Vaping and smoking prevalence among young people in England should continue to be closely monitored.

Questions on flavour preferences and reasons for vaping among young people should be added to large nationally representative surveys.

Enforcement of age of sale regulations needs to be improved.

4. Vaping among adults

4.1 Main findings

Current vaping prevalence (any current use) among adults in England has remained stable since 2014, and in 2019 was between 5% and 7%.

Current vaping prevalence among smokers varied between 14% and 20% across surveys, again showing little change since 2014.

Current vaping prevalence among former smokers has continued to rise and was 12% to 13% in 2019.

Vaping remains most common among smokers and former smokers, with less than 1% of people who have never smoked currently vaping.

The proportion of current smokers who have not tried vaping products remained at 37% between 2018 and 2019.

Smoking among adults in England has continued to decline over the past 10 years and in 2019 was around 15%.

Vaping prevalence is highest among people in more disadvantaged socio-economic groups, reflecting their higher levels of smoking.

Perceptions of harm from vaping among smokers are increasingly out of line with the evidence. The proportion who thought vaping was less harmful than cigarettes declined from 45% in 2014 to 34% in 2019. These misperceptions are particularly common among smokers who do not vape.

Most adults use vaping products to help them quit smoking.

Vapers said that banning flavoured liquids would deter them from using vaping products to help them quit or reduce their smoking. It could also push current vapers towards illicit products.

As in previous years, data from stop smoking services in England suggest that when a vaping product is used in a quit attempt, either alone or with licensed medication, success rates are comparable to, if not higher than, licensed medication alone.

Where international information is available, adult vaping prevalence in England appears to be higher than in other countries.

4.2 Implications

The data presented here suggest that vaping has not undermined the declines in adult smoking.

Increasingly incorrect perceptions among the public about the harms of vaping could prevent some smokers using vaping products to quit smoking.

A ban on flavoured liquids could have adverse effects and unintended consequences for smokers using vaping products to quit. It should only be considered with caution.

5. Vaping among people with mental health conditions

5.1 Main findings

In our systematic review, we did not identify any vaping prevalence studies from England, so we are unable to report on rates of vaping among people with mental health conditions in England, or in other parts of the UK.

We identified 17 studies that reported vaping prevalence in people with mental health conditions outside the UK.

Definitions of current vaping varied across studies, for example any use in the past 30 days or use every day, on some days or rarely. So, the findings and any comparisons between studies should be treated with caution.

Overall, rates of current vaping ranged from 3% to 20% among people with mental health conditions in nationally representative population samples. Rates ranged from 0.3% to 21% in representative state-wide or regional survey samples and from 7% to 45% among participants recruited from clinical settings. These high rates

of vaping likely reflect the high prevalence of smoking among people with mental health conditions.

Among nationally representative and state-wide or regional samples, current smokers had the highest rates of ever vaping (up to 75%) and current vaping rates (up to 41%).

There are currently no published randomised controlled trials (RCTs) evaluating vaping products for smoking cessation or reduction for smokers with mental health conditions. We identified 4 single group 'pre-post studies', a type of study looking at participants before and after an intervention, and a secondary data analysis of RCT data that included a sample of people with a mental health condition. In 4 of the studies, participants were not motivated to quit. Complete abstinence from smoking was achieved by 7% to 14% of participants between 4 weeks and 12-month follow-up across the studies. Study participants who vaped significantly reduced their cigarette intake.

The sparse literature that exists on health professionals' knowledge and attitudes about vaping suggests that many are ambivalent about the role and use of vaping products among smokers with mental health conditions. It also suggests there are unmet training needs.

5.2 Implications

One of the actions in the government's Tobacco Control Plan for England was to explore how more reliable data could be collected to better inform tobacco control measures to support people with mental health conditions. Ongoing studies on vaping (and smoking) in these people in England will help fill some evidence gaps. But more nationally representative data are still needed, particularly for people with severe mental health conditions.

High rates of smoking and vaping together suggests that smokers with mental health conditions should be advised and supported to quit smoking completely, as soon as they feel able to do so.

More research is needed on vaping among people with mental health conditions and its efficacy and safety for quitting smoking.

There are signs that health professionals need more tailored training on the use of vaping products among people with mental health conditions.

Resources on vaping among people in mental health settings are available from the Mental Health & Smoking Partnership in England. Since vaping is allowed in most mental health trusts in England, the experience of using vaping products over time in

these settings should be explored, including their effect on completely switching from smoking to vaping.

6. Vaping during and after pregnancy

6.1 Main findings

Our systematic review showed a lack of evidence on the prevalence of vaping in pregnancy in England, the effects of vaping on smoking during pregnancy and following childbirth, and on the effects of vaping on maternal health or pregnancy outcomes.

As in other populations, pregnant women who vape are likely to do so to stop smoking.

Vaping in pregnancy is very rare among those who have not smoked.

Pregnant smokers and health professionals are unsure about the relative risks of vaping for mother and baby, and clinical practice on vaping in pregnancy varies.

6.2 Implications

The lack of nationally representative data on vaping in pregnancy in England needs to be addressed through research programmes.

More research is needed on the associations between vaping in pregnancy and smoking cessation and health outcomes.

The common reasons for vaping in pregnancy are to stop smoking, prevent a return to smoking and reduce harms. So, any uncertainty about the harms or risks of vaping in pregnancy is likely to discourage vaping by pregnant smokers.

The inconsistent attitudes of health professionals to vaping in pregnancy show that guidance is urgently needed.

While they await the outcomes of ongoing research, health professionals can use guidance and recommendations from the Smoking in Pregnancy Challenge Group on vaping before, during and after pregnancy for maternity and other health professionals. The guidance says that vaping should be supported if it helps women or households with children to quit smoking or stay smokefree and that regulated nicotine vaping products will always be preferable to smoking.

Chapter 1: Introduction

Objective of the report

This report is the sixth in a series of independent reports commissioned by Public Health England to summarise evidence on e-cigarettes to inform policies and regulations [1-5]. Despite reductions in smoking prevalence, smoking remains the largest single cause of preventable death and disease and a leading cause of health inequalities. Hence, alternative less harmful nicotine delivery devices could play a crucial role in reducing this health burden. The extent to which this happens will however depend on several issues in relation to the alternative devices, in particular: health impacts, both in comparison to smoking and in their own right; their influence on young smokers and uptake by never smokers; their influence on quitting smoking; and the extent to which they affect disadvantaged groups in society. These issues have been explored over the series of reports. This report provides the latest evidence on prevalence and characteristics of vaping in young people and adults. As in previous reports, we have paid particular attention to data from England that have emerged since our last report, published in early 2019. We also examine e-cigarette use in 2 groups for whom smoking is particularly disadvantageous: those with mental illness and pregnant women. Subsequent reports will update the evidence on smoking cessation and health effects of e-cigarettes.

Terminology

E-cigarettes contain a battery-powered heating element designed to aerosolise a solution of propylene glycol and/or glycerol, water, typically nicotine (freebase or nicotine salts) and flavours. However, they comprise a heterogeneous category of products (see below) and many do not resemble tobacco cigarettes so the term e-cigarette will not be used here. In the remainder of this report, we therefore use the term 'vaping products' to describe e-cigarettes and refill containers (e-liquids), we use the term 'vapers' to refer to people who regularly use vaping products or e-cigarettes and 'vaping' as the act of using an e-cigarette or vaping product. Our terms do not include cannabis vaping or the vaping of other illicit substances, which are not the subject of this report.

Vaping products

Vaping products come in various types and shapes. They currently range from:
- one-time disposable products (often referred to as cigalikes)
- reusable, rechargeable kits designed with replaceable cartridges or pods

- reusable, rechargeable kits designed to be refilled with liquid by the user (often referred to as tanks, but there are now also refillable pods available)
- reusable, rechargeable kits, often referred to as 'mods' (modifiables) that allow users to customise their product such as by regulating the power delivery from the batteries to the heating element (sometimes these are included with other tank models)

The shape of these products varies enormously from cigarette shapes, flat, memory-stick shapes, to pebbles, pens and different shapes and sizes found in box mods.

Nicotine salts are an alternative to the freebase nicotine found in combustible cigarettes and many vaping products. Nicotine salts became popular when the product 'JUUL' was released onto the market in the US in 2015. This product has more recently (July 2018) been brought to market in England. Other brands also now use nicotine salt technology. Freebase nicotine has a higher pH and hence higher alkalinity and a harsh hit to the throat when inhaled. Adding benzoic acid to naturally occurring nicotine salts lowers the pH level, reducing the alkalinity, enabling a smoother throat-hit and for some users, purportedly providing a sensation that is more similar to smoking. Additionally, nicotine salts allow vaporisation at a lower temperature and enable higher nicotine levels to be inhaled. Nicotine salts work in smaller lower wattage devices, such as pod systems.

Vaping products are produced by tobacco industry companies and companies that are independent of the tobacco industry. About two-thirds of vaping products in the UK market are currently manufactured by independent companies, whereas a small majority of vaping products on the US market are manufactured by companies with at least some tobacco industry ownership (ECigIntelligence – personal communication).

In the context of tobacco industry influence, it is also notable that public health policy governance in the UK was recently rated as the best at resisting interference from the tobacco industry [6].

Current vaping regulations in England

Vaping products that do not contain nicotine fall under General Product Safety Regulations, enforced by Trading Standards. Vaping products that contain nicotine are regulated more stringently through the Revised European Union Tobacco Products Directive (EU TPD) [7] translated into UK law through the Tobacco and Related Products Regulations 2016 (TRPR) [8]. The national competent authority for these regulations is the Medicines Healthcare products Regulatory Agency (MHRA) acting for the Secretary of State for Health. Table 1 gives a brief overview of the regulations pertaining to nicotine-containing vaping products in the UK.

Table 1: Nicotine-containing vaping products regulation summary

Notification requirements
- nicotine containing vaping product manufacturers must submit a range of details to MHRA before putting a product on the market and update when products are manufactured or withdrawn

Maximum capacities and nicotine strength allowed

- tank capacity: 2ml
- vaping-liquid refill container capacity: 10ml
- nicotine strength of e-liquid: 20mg/ml

Other safety and quality standards
- child-resistant and tamper evident packaging
- prohibition of certain additives such as colourings and vitamins
- protection against breakage and leakage, and a mechanism for ensuring refilling without leakage

Information provision
- health warning and provision of information on pack or device/bottle

Advertising
- all broadcast media and cross-border advertising prohibited
- domestic advertising allowed such as outdoor, posters, cinema, etc
- all advertising must adhere to a Committee of Advertising Practice Code (Code 22; see below)
- health claims on advertising are allowed under strict conditions (see below)

Age of sale law
- 18 years and proxy purchasing also prohibited

Public places
- no legislation but local proprietors or organisations can decide

These regulations are similar to those throughout the European Union.

A fuller description of all the regulations in England was provided in our earlier reports [3-5] and we only give details of any recent relevant developments in the subsequent sections.

MHRA Yellow Card Scheme

The MHRA runs a Yellow Card Scheme for vaping products (https://www.gov.uk/drug-safety-update/e-cigarettes-and-refill-containers-e-liquids-report-suspected-side-effects-and-safety-concerns). This is a public-facing scheme by which anyone can report to the Agency an adverse reaction which they suspect may have been caused by vaping. A report such as this is not by itself proof of a side effect or a causal link between vaping and an adverse reaction.

Following a data request to the MHRA, it informed us that between 20 May 2016 (implementation of TRPR) and 9 January 2020, it had received 84 reports of 245 adverse reactions believed to be associated with nicotine containing vaping products (Table 2) [9]. The MHRA determines the seriousness of a report based on whether the reaction term is considered serious in the medical dictionary, MedDRA, which is used to code all adverse reaction reports, and the Council for International Organisations of Medical Sciences seriousness criteria. By 9 January 2020, 57 reports were considered serious. Inclusion of a report is not proof that the reaction was caused by a vaping product, just that the reporter had a suspicion it might have been. Other factors such as patient medical history and concomitant medications may have caused or contributed to the observed symptoms. The MHRA also informed us that, in October 2019, it requested vigilance information from all producers of vaping products relating to all respiratory reactions associated with e-cigarettes; this resulted in 137 cases reported to the MHRA by industry.

Also, in the UK, there are 2 published case studies of people with severe respiratory illnesses that might have been vaping-related. In 2018, Viswam et al. [10] described a case of a 34-year-old woman with respiratory failure caused by lipoid pneumonia. The patient had several chronic health conditions, was a former smoker, and had vaped for 3 years. The medical team treating her believed the lipoid pneumonia was caused by inhaling vegetable glycerine in e-liquid. Viswam et al. [10] and further reported that the patient had some improvement in her symptoms over 18 months, despite continuing to vape. In 2019, Nair et al. [11] described a case of hypersensitivity pneumonitis in a healthy 16-year-old young man related to recent frequent vaping of 2 different types of e-liquids purchased from a retail outlet. An acute immune reaction to the e-liquids was identified as the likely cause of the pneumonitis. Nair et al. [11] reported that the patient was asymptomatic after 14 months. It is not clear whether these 2 cases were notified through the Yellow Card Scheme reported above.

The MHRA also informed us that it had recently received reports of 2 suspected fatal cases (Table 2). The first of these reported an unknown cause of death and another case was reported suggesting the person had died due to a vaping related lung injury. Due to confidentially reasons, the MHRA was unable to provide us with any further information about these deaths. It is not clear at the time of writing, if the causes of

these deaths have been confirmed by a coroner. There is more information in the January 2020 MHRA drug safety update [12].

Table 2: MHRA Yellow Card reports of adverse reactions associated with vaping (20/5/2016 to 9/1/20)

Reaction name	Total	Fatal
Cardiac disorders	9	0
Endocrine disorders	1	0
Eye disorders	4	0
Gastrointestinal disorders	43	0
General disorders	37	1
Immune system disorders	10	0
Infections	3	0
Injuries	13	1
Investigations	2	0
Metabolic disorders	1	0
Muscle and tissue disorders	2	0
Nervous system disorders	20	0
Pregnancy conditions	1	0
Product label/physical/quality issues	8	0
Psychiatric disorders	3	0
Respiratory disorders	73	0
Skin disorders	13	0
Vascular disorders	2	0
Total reactions for drug	245	2
Total reports	84	0
Total fatal outcome reports		2

It is worth noting that between 1 January 2016 and 30 November 2019 there were 1,847 reactions reported through the Yellow Card Scheme for the smoking cessation medicine varenicline, including 9 fatalities [13]. Additionally, over the same period there were 875 reactions reported for nicotine replacement therapies, including 5 fatalities [14]. Due to differences in adverse reaction reporting requirements between marketing authorisation holders of smoking cessation licensed medicines and vaping product producers, it is not possible to directly compare the number of reports, therefore we have included this information for context only. Adverse reaction reporting rates are influenced by the seriousness of adverse reactions, their ease of recognition, the extent of use of a particular product, and may be stimulated by promotion and publicity about a product. There is a requirement for all medicinal products to have details of reporting to the Yellow Card Scheme in their product information. However, this does not extend

to vaping products (although under the regulations of the TRPR, companies do have responsibility to monitor and collect data themselves and to inform the MHRA if they consider there to be a safety concern).

Pre-TRPR suspected adverse reactions

The MHRA reported to us that it received a further 23 yellow card reports associated with vaping products prior to the TRPR coming into force. These were outside the remit of the MHRA at the time but were retained with the understanding that there was no alternative reporting system.

The MHRA also provided information to us that prior to the TRPR coming into force, and the launch of Yellow Card Scheme for reporting suspected adverse reactions for vaping products, it received reports of 2 suspected fatal cases. This included a case of lipoid pneumonia reported in 2011 and a case of fatal cardiac arrest reported in 2016. It is important to note that prior to TRPR, nicotine vaping products were unregulated. Details on these reports are not available publicly.

Media reports from 2011 [15] and 2019 [16] indicate that a gentleman died from lipoid pneumonia 8 months after switching from smoking to vaping. An open verdict was recorded at the time. It is unclear if the case of lipoid pneumonia reported to the MHRA in 2011, refers to this gentleman.

Age of sale

There is a minimum age of sale of 18 for vaping products and people are prohibited from purchasing vaping products on behalf of someone under the age of 18 (proxy purchasing).

A survey of tobacco control activities in Trading Standards Services was carried out by the Chartered Trading Standards Institute (CTSI) between April 2018 and March 2019 [17]. Of the participant councils (129 of 151), 55% conducted activities in relation to underage sales of vaping products (compared to 83% for tobacco). Where respondents were able to provide detail, 210 complaints were received and enquiries relating to 154 premises: the highest ranked premises were specialist vaping product suppliers followed by independent newsagents. By comparison, of those councils able to provide detail on tobacco complaints, 815 complaints and enquiries were received associated with 691 premises: the highest ranked premises were convenience stores or grocers followed by off-licences [17].

Just over half (51%, n=34) of the councils reporting activities in relation to underage sales of vaping products conducted test purchase operations with volunteer young people. The number of premises visited was 227, with 90 (40%) test purchase attempts

resulting in an underage sale being made. This was reported to be an increase on the previous year. Specialist vaping product suppliers were the most common premise where underage sales occurred, followed by discount shops and market/car boot sales. The most common action taken was a verbal or written warning. A similar exercise to assess sales of tobacco or cigarettes to underage test purchasers, was carried out by 66% of councils reporting activities in relation to underage sales of tobacco products, which reported 18% (157 out of 854) of test purchase attempts resulted in a sale. Sales were made most commonly in convenience stores, followed by independent newsagents and off licences. Again, this was reported to be an increase from 2017 to 2018 [17].

The same survey reported that 69 councils made 1,273 visits to assess compliance of nicotine containing vaping products with regulations. Non-compliant products were found in 17% of visits (this compares with 41 councils making 2,331 visits and finding non-compliant tobacco products in 18% of visits). Non-compliant vaping products were most commonly found in specialist vaping suppliers (41%), followed by convenience stores/grocers (14%) and discount shops (13%).

Action on Smoking and Health (ASH) has reported that the MHRA could review fees for vaping product notifications to better resource trading standards officers to carry out enforcement checks [18].

In a recent ASH survey, the vast majority of retailers reported that they supported the age of sales law for vaping products (84%) and that it had no impact (78%) on their business (with 9% reporting it having a positive impact and 1% negative). Prohibiting proxy purchasing was also popular among retailers (81% supportive) with 80% reporting no impact on their business (7% positive impact, 3% negative) [19].

Medicinal vaping products

There are still no vaping devices licensed as a medicine and available on the market. The MHRA's guidance remains the same as reported previously (www.gov.uk/guidance/licensing-procedure-for-electronic-cigarettes-as-medicines), but in December 2018 the MHRA announced that the Committee on Safety of Medicines would convene a group to advise whether and how the requirements for vaping product licensing could be further streamlined or simplified for companies applying for an vaping product licence [20]. The final report of this group has not yet been published.

Advertising

We reported previously that the blanket ban on health claims on permitted forms of vaping product advertising (ie. domestic channels) was lifted in November 2018 [5]. The guidance for any such health claims was quite restrictive including being product

specific and needing to be supported by evidence that the specific vaping product possessed the health benefit. To our knowledge, no marketers for vaping products have made a health claim. This should remain under review and be included in any vaping product regulatory review.

A number of organisations, including ASH have complained about the use of social media to promote tobacco and nicotine products. In the UK, the Advertising Standards Authority (ASA) investigated the use of social media platforms to promote vaping products by vaping companies [21]. In December 2019, it published its responses, upholding 2 complaints on Attitude Vapes (an e-cigarette retailer) [22], 2 complaints on Global Vaping Group Ltd t/a Mylo Vape UK, an e-cigarette retailer, and 2 complaints on Ama Vape Lab Ltd [23], and partially upheld complaints about British American Tobacco UK Ltd [24]; all had breached elements of the E-cigarette Advertising Code 22 [25], specifically promoting nicotine-containing e-cigarettes and their components which were not licensed as medicines (from a public Instagram account) [26], and/or showing people using e-cigarettes or playing a significant role who seemed to be under 25 years of age, and/or appealing to people under 18 years. Complaints against Imperial Tobacco Ltd [27] for advertisements which were felt to breach the Code by encouraging non-smokers or non-nicotine users to use e-cigarettes were not upheld.

NHS Long Term Plan

We reported previously on the publication of the NHS Long Term Plan [28]. Of relevance to this review was the statement that by 2023 to 2024, a new universal smoking cessation offer would be available as part of specialist mental health services for long-term users thereof and in learning disability services, including the option to switch to vaping while in inpatient settings.

We also reported previously the recommendations of the House of Commons Science and Technology Committee on e-cigarettes (HoC) and the Government's response [29, 30]. The HoC recommended that NHS England should set a clear central NHS policy on vaping in mental health facilities, establishing a default of allowing patients to vape unless an NHS trust can demonstrate evidence-based reasons for not doing so. It also recommended NHS England issue vaping guidance to all NHS mental health trusts to ensure they understand the physical and mental health benefits for their patients. To date, guidance has not been issued (in the Government's response, no timeline was given).

Despite a lack of national guidance, the majority of NHS mental health Trusts in England allow vaping. ASH [31] commissioned by PHE, conducted a survey of all (n=54) mental health Trusts in England about their progress to implement smokefree policies. Forty-five NHS Trusts responded to the survey; 37/45 (82%) prohibited

smoking on all trust premises (see Tobacco Control Ambition below) and 41/45 (91%) allowed vaping in hospital settings. All 41 Trusts that permitted vaping allowed patients to use non-rechargeable, disposable varieties. In 14 Trusts non-rechargeable, disposable devices were the only models that were allowed, whereas 21 Trusts allowed all types of vaping devices to be used. Twenty Trusts (44%) allowed vaping indoors, most often only in single use bedrooms. Nineteen of the surveyed Trusts (42%) provided vaping devices free to their patients; 9 (20%) sold them on wards or in hospital shops (22%). National guidance would however be welcomed to encourage consistency and equity across the NHS [31]. Other guidance is available from the Royal College of Psychiatrists [32], and the Mental Health and Smoking Partnership in England [33] on vaping in people who use mental health services.

Tobacco Control Plan for England

As detailed in previous reports, the Tobacco Control Plan for England [34] set out ambitions to:

- reduce the prevalence of 15-year-olds who regularly smoke to 3% or less (assessed by the Smoking, Drinking and Drug Use Survey by the end of 2022 (see Chapter 3)
- reduce smoking prevalence among adults in England from 15.5% to 12% or less by the end of 2022 (assessed by the Annual Population Survey, see Chapter 4)
- reduce the prevalence of smoking in pregnancy to 6% or less by the end of 2022 (assessed by the Smoking Status at Time of Delivery – NHS (SATOD), see Chapter 6)
- reduce the inequality gap in smoking prevalence between those in routine and manual occupations and the general population (assessed by the Annual Population Survey, see Chapter 4)
- improve data collected on smoking and mental health to help support people with mental health conditions to quit smoking and make all mental health inpatient services sites smokefree by 2018 (see above)
- help people to quit smoking by permitting innovative technologies that minimise the risk of harm and maximise the availability of safer alternatives to smoking

Review of TRPR vaping regulations

The UK government has a legal duty to review any legislation that affects business within 5 years, so the TRPR vaping regulations will need to be reviewed by 20 May 2021. The government will need to assess if the legislation is achieving its objectives, review health and economic impacts and recommend whether it should remain in force, be amended or revoked.

International developments

In the period since our last review, the agenda outside the UK has been dominated by the so-called vaping epidemic among young people (see Chapter 3), an outbreak of acute lung injuries associated with vaping adulterated tetrahydrocannabinol (THC) products and the prohibition of flavoured vaping, or all, products.

E-cigarette, or vaping, product use associated lung injury (EVALI) outbreak

In March 2019, cases of lung disease (cough, shortness of breath, difficulty breathing, fatigue, vomiting, fatigue) that may have been attributable to using a vaping product began to emerge in the US with a rapid increase occurring in August and September [35] which have since steadily declined [36]. Patients were most commonly young, male and white [36]. The first death of an individual who had recently vaped and was hospitalised with severe respiratory illness occurred on 23 August 2019 and was reported by the Illinois Department of Public Health [37]. Further reports and analyses followed, identifying tetrahydrocannabinol (THC) – containing products as a common factor among patients as well as vitamin E acetate [38-40].

The CDC has indicated that, overall, 80% of hospitalised EVALI patients self-reported or were reported by proxies (eg. family members) to have used tetrahydrocannabinol (THC)-containing e-cigarette, or vaping, products [36]. The CDC acknowledges that there are limitations with self- or proxy-reported data of substances used in e-cigarette, or vaping, products, eg. they may be due to recall or social desirability bias [36].

It also suggests that it is "unlikely a single brand is responsible for the EVALI outbreak, 'Dank Vapes', a class of largely counterfeit THC-containing products of unknown origin, were the most commonly reported THC-containing branded products nationwide and among all major US Census regions. However, regional differences in THC-containing product use were noted; TKO and Smart Cart brands were more commonly reported by patients in the West region compared with other regions." Vitamin E acetate was found in the vast majority of THC containing products collected from EVALI case patients and tested by the FDA [36]. Bronchoalveolar lavage fluid was analysed from a convenience sample of 51 EVALI case patients from 16 states and vitamin E was detected in 48 patients (94%) [40].

As of 21 January 2020, 2,711 hospitalised cases of EVALI or deaths had been reported to the CDC. These were from all 50 states, the District of Columbia and 2 US territories (Puerto Rico and US Virgin Islands); there had been 60 deaths reported from 27 states and the District of Columbia [41].

As of 28 January, 2020 the CDC and FDA recommended "that people not use THC-containing e-cigarette, or vaping, products, particularly from informal sources like friends, family, or in-person or online dealers" [41]. Further recommendations by the CDC can be found here www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html.

The UK media also extensively reported on the US vaping injuries and deaths (eg. [42]). It should be noted that in England THC is prohibited and vitamin E (like other vitamins) is prohibited in regulated nicotine vaping products [43]; current advice from PHE recommends vaping products should not be modified or used with homemade or black-market cartridges containing illicit substances [44].

Flavour regulations

Regulations in the US differ from those in the EU in a number of ways, such as there are no nicotine content limits in the US and advertising is allowed, though 'nicotine addictiveness warning statements' on product packages and advertising is required [45] (www.fda.gov/tobacco-products/products-ingredients-components/vaporizers-e-cigarettes-and-other-electronic-nicotine-delivery-systems-ends).

In the US, at the Federal level, on 11 September 2019 [46], the Trump administration announced that they intended to ban flavoured vaping products to "tackle the epidemic of youth e-cigarette use" (www.fda.gov/news-events/press-announcements/trump-administration-combating-epidemic-youth-e-cigarette-use-plan-clear-market-unauthorized-non − see Chapter 4), although media reports also linked this announcement to the spate of EVALI related deaths (www.bbc.co.uk/news/world-us-canada-49667688).

In response to the "lung injury outbreak", 7 US states (Massachusetts, Michigan, Montana, New York, Oregon, Rhode Island, Washington) and 8 large cities (Los Angeles, San Francisco, Chicago, San Diego, San Jose, Boston, Philadelphia, Baltimore) announced bans on sale of vaping products or flavour bans.

In December 2019, an amendment to the Federal Food, Drug, and Cosmetic Act, the minimum age of sale of tobacco products (including e-cigarettes) was raised from 18 to 21 years of age.

On 2 January 2020, the FDA stepped back from recommending a full flavour ban, announcing instead that it will ban fruit- and mint-flavoured cartridge/pod vaping products, while allowing vape shops to continue to sell flavours for tank-based systems. Beginning 30 days from the publication of Enforcement Priorities for Electronic Nicotine Delivery Systems (ENDS) and Other Deemed Products on the Market Without Premarket Authorisation [47], the FDA stated it intends to "prioritize enforcement

against these illegally marketed ENDS products by focusing on the following groups of products that do not have premarket authorization:

- any flavored, cartridge-based ENDS product (other than a tobacco- or menthol-flavored ENDS product);
- all other ENDS products for which the manufacturer has failed to take (or is failing to take) adequate measures to prevent minors' access; and
- any ENDS product that is targeted to minors or likely to promote use of ENDS by minors."

The US intends to bring in an authorisation process for vaping products in May 2020. Specifically, to receive approval to sell their products, vape manufacturers are required to submit a Pre-Market Tobacco Product Application. This includes scientific information about the risks and benefits of using the products, which involves an extremely costly process that is expected to considerably shrink the pool of vape retailers in the US in the early 2020s (www.fda.gov/regulatory-information/search-fda-guidance-documents/premarket-tobacco-product-applications-electronic-nicotine-delivery-systems-ends).

Other countries, including South Korea, China, India, Mexico, Israel and Canada, have also reacted with policy changes.

Relative harms of smoking and vaping

A substantial safety review of nicotine containing vaping products is being commissioned by PHE for a future evidence update, so safety issues are not updated here. It is however clear that the spate of lung injuries and deaths are not attributable to the regulated nicotine vaping products currently marketed in England. We recommend that the conclusions of previous reviews concerning relative differences in harm between smoking combustible cigarettes and regulated nicotine vaping products should continue to be communicated. These can be broadly summarised as:

- vaping regulated nicotine products has a small fraction of the risks of smoking, but this does not mean it is 'safe'
- smokers should be encouraged to try regulated nicotine vaping products along with smoking cessation medications and behavioural support. This will greatly increase their chances of successfully stopping smoking
- people who have never smoked should be encouraged not to smoke and not to vape
- vapers should be encouraged to use regulated nicotine products only and stop smoking completely

Structure of the report

Following this introductory chapter, Chapter 2 describes the methods used in compiling this report. Chapter 3 provides the latest evidence on vaping among young people and Chapter 4 the latest data on vaping among adults; these chapters focus on England, drawing on surveys from England, Great Britain and the UK, but a brief overview is also given of the international situation. Chapter 5 presents a systematic review of the international evidence of vaping in smokers with mental health conditions and Chapter 6 a systematic review of the international evidence of vaping in pregnancy.

Conclusions

We use the term 'vaping products' to describe e-cigarettes and refill containers (e-liquids).

We use the term 'vapers' to refer to people who regularly use vaping products and 'vaping' as the act of using a vaping product.

Our terms do not include cannabis vaping or the vaping of other illicit substances, which are not the subject of this report.

Nicotine vaping products have continued to evolve. The use of nicotine salt technology is becoming more popular.

There are no medicinally licensed nicotine vaping products in the UK. Selling vaping products to anyone under 18 is prohibited and so is buying vaping products for anyone under 18.

Non-nicotine containing vaping products fall under the General Product Safety Regulations 2005, enforced by local trading standards.

Nicotine-containing vaping products are regulated more stringently through the revised European Union Tobacco Products Directive (2014/40/EU) (TPD), translated into United Kingdom (UK) law through the Tobacco and Related Products Regulations 2016 (TRPR), which the government has committed to review by May 2021.

Between 20 May 2016 (implementation of TRPR) and 9 January 2020, the Medicines and Healthcare products Regulatory Agency (MHRA) had received 84 reports of 245 adverse reactions believed to be associated with nicotine containing vaping products through its Yellow Card Scheme. A report is not proof that the reaction was caused by a vaping product, just that the reporter suspected it might have been.

In the US, where there is a very different regulatory system for vaping products (including products used to vape cannabis), there was a spate of serious lung diseases and deaths which appeared to peak in late 2019. This outbreak appears to have been caused by people vaping the cannabis derivative tetrahydrocannabinol (THC) oil and vitamin E acetate.

There has been no similar lung disease outbreak in England, although the MHRA has received reports of 4 deaths through its Yellow Card Scheme where vaping was suspected to be implicated (2 before implementation of TRPR and 2 more recently). However, the connection with nicotine containing vaping products has not yet been established. There is more information in the January 2020 MHRA Drug Safety Update. There are also 2 published serious cases of respiratory illness that have been linked to vaping.

Violations of the age of sale law for nicotine-containing vaping products (and for cigarettes) and the use of social media to promote vaping products are being reported. The Advertising Standards Authority recently upheld some complaints where the marketing of vaping products had violated the UK Advertising Code.

Most mental health trusts in England allow vaping but there are inconsistencies in policy and practice. The report of the House of Commons Science and Technology Committee enquiry on e-cigarettes recommended that NHS England produce guidance on vaping in mental health trusts, which is still outstanding.

Implications

Since non-nicotine vaping products are less stringently regulated than nicotine-containing products, they may need to be reviewed alongside the forthcoming review of nicotine vaping regulations.

NHS England should issue guidance on vaping in mental health trusts to make sure there is consistency and equity across the NHS.

The spate of lung injuries and deaths in the US is not attributable to the regulated nicotine vaping products currently sold in England. But all suspected adverse reactions or suspected deaths need to be assessed.

The conclusions of our previous reports are still important messages for preventing harm. These can be broadly summarised as:

- vaping regulated nicotine products has a small fraction of the risks of smoking, but this does not mean it is safe

- smokers should be encouraged to try regulated nicotine vaping products along with smoking cessation medications and behavioural support. This will greatly increase their chances of successfully stopping smoking
- people who have never smoked should be encouraged not to smoke and not to vape
- vapers should be encouraged to use regulated nicotine products only and stop smoking completely

Chapter 2: Methods

This report used several data sources to update the evidence on vaping in England. Estimates of vaping prevalence among young people and adults that form the basis of Chapters 3 and 4 were derived from data produced by 6 national surveys. These surveys, their provenance, geographical coverage, sampling and design are described in Table 3 (young people) and Table 4 (adults). The report also reviewed national estimates of vaping prevalence from countries outside of England using data from the published academic literature.

To identify the available evidence on vaping in people with mental health conditions and vaping in pregnancy, systematic reviews were conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [48]. The search strategy, inclusion criteria and other methods followed in conducting these systematic reviews are described in detail in this chapter.

Young people and adult surveys

The surveys used to estimate prevalence of vaping in young people were the ASH Smokefree Great Britain Youth survey (ASH-Y), the Smoking, Drinking and Drugs Survey (SDD) and the Smoking Toolkit Study (STS) (Table 3). Vaping prevalence among adults was analysed using the ASH Smokefree Great Britain Adult Survey (ASH-A), the Opinions and Lifestyle Survey (OPN), the Annual Population Survey (APS) and the Smoking Toolkit Study (STS) (Table 4).

Table 3: Surveys used to estimate vaping prevalence among young people

Survey name and acronym	Commissioned and conducted by	Geographic coverage, sample	Age	Representativeness	Design
Smoking, Drinking and Drugs Survey (SDD)	NHS Digital and Ipsos Mori	England survey conducted every 2 years. 2018 survey data collected between September 2018 and February 2019 from 193 schools and 13,664 pupils	11 to 15 years	Sampling strategy is designed to be representative and results are weighted to represent the school population	Two-yearly face to face paper survey questionnaires where pupils are surveyed as a class under exam conditions. Repeated, cross-sectional survey of 3 classes in each participating school
ASH Smokefree Great Britain Youth survey (ASH-Y)	ASH and YouGov Plc	GB[1] survey of ~2,500 young people. Survey in 2019 conducted between 12 March and 3 April n in 2019 = 2,523	11 to 18 years	Figures weighted to be representative of GB children	Annual online, repeated, cross-sectional survey recruited from a YouGov Plc UK panel of more than 800,000 members
Smoking Toolkit Study (STS)	University College London and Ipsos MORI	England survey of ~ 1,700 people per month aged 16+. n in 2019 (to November) = 18,862	16 to 17 years (for Chapter 3)	Sample weighted to match census data	Monthly household survey consisting of face-to-face interviews

[1] Where surveys covered GB, data for England were identified and analysed for the present report.

Table 4: Surveys used to estimate vaping prevalence among adults

Survey name and acronym	Commissioned and conducted by	Geographic coverage, sample	Age	Representativeness	Design
Annual Population Survey (APS)	Office for National Statistics	UK[1] survey of 122,000 households and 320,000 respondents	16+ years	Systematic sampling ensures representativeness at a regional level. Weighting is used to reflect official UK population data	Annual Household survey conducted face-to-face, by telephone or through computer assisted interviews and taken in 4 waves throughout each year
Smoking Toolkit Study (STS)	University College London and Ipsos MORI	England survey of ~1,700 people per month aged 16+. n in 2019 (to November) = 18,862	16+ years	Sample weighted to match census data for England	Monthly household survey consisting of face-to-face interviews
Opinions and Lifestyle Survey (OPN)	Office for National Statistics	GB[1] survey of 1,200 households n in 2018 = 8,303	16+ years	Sampling is stratified and data are weighted to be representative of the GB population	Monthly household, face-to-face, repeated, cross-sectional survey
ASH Smokefree Great Britain Adult Survey (ASH-A)	ASH and YouGov Plc	GB[1] survey of ~12,000 adults. Survey in 2019 conducted between 12 February and 10 March n in 2019 = 12,393	18+ years	Figures weighted to be representative of GB adults	Annual online, repeated, cross-sectional survey recruited from a YouGov Plc UK panel of more than 800,000 members

[1] Where possible, data for England only were analysed when using data from surveys that covered GB or UK.

Literature review on international vaping prevalence

The peer-reviewed research literature was reviewed for estimates of vaping prevalence from countries outside of England. A search was conducted on Embase, Medline, PsycInfo and PubMed databases for articles published after 5 November 2018 (the date of the final search used in the previous report on vaping [5]) and before 18 October 2019. The search term from that previous report was used here to ensure consistency across reports.

> "Electronic Nicotine Delivery Systems"[Mesh] OR (e-cig*) OR (electronic cig*) OR (ENDS AND Nicotine) OR (electronic nicotine delivery system*) OR ((Nicotine) AND (Vaping* OR Vape* OR Vaporiz* OR Vaporis* OR Vapouris*))

The titles and abstracts of articles identified by this search term were screened by one author with full-text inclusion decisions made by 2 authors. Articles were included where they presented new, nationally representative data on adult or youth vaping prevalence. Articles were excluded if the data they reported were not nationally representative or if the article had been included in previous PHE reports on vaping.

Systematic literature reviews

Two systematic literature reviews were completed and were used as the basis for Chapters 5 and 6. The protocols for both systematic reviews are summarised here and were registered in advance on PROSPERO [49], and are described in detail in the relevant chapters. Those methods are therefore summarised here.

Systematic review of vaping among people with a mental health condition

The full registration protocol can be found at www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019137747 and in the appendices. This systematic review formed the basis of Chapter 5 and was designed to answer the following research questions:

Among people with a mental health condition:

1. What is the prevalence of vaping?
2. What are the characteristics of vaping, eg. device used, frequency of use, nicotine strength and flavours used?
3. What are the effects of vaping on smoking cessation or reduction?
4. What are the physical and mental adverse effects of vaping?
5. What are the benefits of vaping on physical and mental health outcomes?
6. What are the reported barriers and facilitators of vaping?

The literature was identified through searches of CINAHL, Embase, Medline, PsycInfo and PubMed databases. The search was conducted on 10 September 2019 (no start date for the search was specified) using the following search term, with minor changes to the syntax made to match the requirements of different databases:

> ((exp electronic cigarette/) OR (e-cig*) OR (electronic cig*) OR (ENDS AND Nicotine) OR (electronic nicotine delivery system*) OR ((Nicotine) AND (Vaping* OR Vape* OR Vaporiz* OR Vaporis* OR Vapouris*))) AND ((exp Mental Health Services/) OR (exp Mental Disorders/) OR (psychiatric treatment.mp.) OR (exp Mentally Ill Persons/) OR (exp Mental Health/) OR (exp Anxiety Disorders/) OR (Anxiety.mp.) OR (exp Mood Disorders/) OR (mental health.mp.) OR (exp depression/) OR (exp Schizophrenia/) OR (exp "Bipolar and Related Disorders"/) OR (bipolar.mp.) OR (exp Stress Disorders, Post-Traumatic/) OR (PTSD) OR (Emotional distress.mp.) OR (Psychological distress.mp.))

Articles were included where they were peer-reviewed and reported data on vaping by people with a mental health condition. Articles were excluded where they reported data from animal studies, in vitro studies or studies published in a language other than English, French, German or Italian. One author screened all titles and abstracts with a subsection second-screened by a separate author. Full-text screening and data extraction was completed independently by 2 authors. Agreement between authors was measured using Cohen's kappa [50].

Included studies were assessed for potential bias or quality. Hoy and colleagues' method was used to assess the risk of bias in prevalence studies [51], the Newcastle-Ottawa Scale was used for cohort studies [52]. The Consolidated Criteria for Reporting Qualitative Research (COREQ) [53] is a system that grades qualitative studies against a checklist of required items and was used to assess the quality of qualitative studies. It is important to note that, although COREQ gives a quality score out of 32, this does not assess risk of bias, rather indicates the quality of the study. Studies relating to smoking cessation were also assessed against the hierarchy of methodological criteria proposed by Villanti and colleagues [54].

Systematic review of vaping in pregnancy and postpartum

The full registration protocol for this systematic review can be found at www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019136150 and in the appendices. It formed the basis of Chapter 6 and was designed to answer the following review questions:

1. What is the prevalence of vaping during pregnancy and post-partum?
2. Among people who vape during pregnancy, what patterns of use are identified; eg. frequency of use, vaping products, strength and flavour of e-liquid.

3. Among people who vape during pregnancy, what reasons for use and perceptions are identified?
4. What are the effects of vaping on smoking cessation or reduction during pregnancy and post-partum?
5. Which health outcomes have been reported in studies of vaping in pregnancy and what findings have been associated with these outcomes?
6. What are the reported barriers and facilitators of vaping in pregnancy?

The same literature databases that were searched for the mental health systematic review were searched with the addition of one pregnancy specific database. The databases were CINAHL, Embase, Medline, PubMed and Maternity and Infant Care Database (MIDIRS). The following search term was used in 16 September 2019 (no start date for the search was specified with minor changes to the syntax made according to the requirements of individual databases:

> ((exp electronic cigarette/) OR (e-cig*) OR (electronic cig*) OR (ENDS AND Nicotine) OR (electronic nicotine delivery system*) OR ((Nicotine) AND (Vaping* OR Vape* OR Vaporiz* OR Vaporis* OR Vapouris*))) AND((exp pregnancy/ OR exp pregnancy complications/ OR exp maternal health services/ OR exp fetus/ OR exp fetal therapies/ OR exp fetal monitoring/ OR exp perinatal care/ OR exp labor pain OR exp analegsia, obstetrical/ OR exp obstetric surgical procedures/ OR exp infant, newborn/ OR exp postpartum period/ OR exp breast feeding/ OR exp prenatal diagnosis/ OR exp obstetrics/ OR exp prenatal education/)) OR ((breast-feeding education OR parturition OR ante natal OR antenatal* OR pre natal* OR prenatal* OR puerper* OR postnatal* OR postpartum OR post partum OR post natal* OR peripartum OR peri partum OR prepregnancy OR pre pregnancy OR preconception* OR pre conception* OR periconception* OR peri conception* OR ((preterm OR premature) and (labor OR labour)) OR eclamp* OR preeclamp* OR pre eclamp* OR amniocentes* OR chorion* vill* OR breastfe* OR breast fe* OR lactation* OR cesarean OR caesarean OR cesarian OR caesarian OR cesarien OR caesarien OR newborn* OR new born* OR tocoly* OR fetal OR foetal OR fetus OR foetus OR miscarriage* OR pregnancy OR pregnancies OR pregnant).ti,ab,kf.)

Articles were included where they were peer-reviewed and reported data on vaping in pregnancy. Articles that reported data from animal studies, in vitro studies or studies published in a language other than English, French, German or Italian were excluded. Titles and abstracts were screened by one author with a subsection screened by a second author. Interrater agreement between authors was measured using Cohen's kappa [50]. Two authors completed full-text screening with differences discussed and resolved with a third. Data were extracted from the included studies by 2 authors using the data extraction protocol described in the PROSPERO [49] registrations documents.

Included studies were assessed for potential bias or quality. Hoy and colleagues' method was used to assess the risk of bias in prevalence studies [51], the Newcastle-Ottawa Scale was used for cohort studies [52] and COREQ [53] was used to assess the quality of qualitative studies.

Chapter 3: Vaping among young people

Objective

This chapter summarises the up-to-date evidence on vaping in young people in England. The focus of this chapter is on vaping prevalence, but it will also present data on cigarette smoking for comparison. Additionally, data on vaping product preferences, where young people obtain vaping products, perceptions of harm and reasons for use are included. The chapter also summarises the international academic literature on vaping prevalence enabling comparisons to be made between England and other countries.

Surveys

The 3 surveys used in this chapter are the Smoking, Drinking and Drugs Survey in England (SDD), the ASH Smokefree Great Britain survey of youth (ASH-Y), and the Smoking Toolkit Study (STS) in England. The methodologies used to collect data for these surveys are described in detail in Chapter 2 and in Table 3. The most recent SDD data were collected between September 2018 and February 2019 from people between age 11 and 15. The most recent ASH-Y survey data were collected in March and April 2019 from people between age 11 and 18. The 2019 STS data were collected between January and November 2019 and this chapter includes data from people age 16 and 17 only.

The SDD survey collects data from a large, nationally representative sample of schoolchildren and is used by the UK government to monitor smoking behaviour in 11- to 15-year-olds in England. This chapter will therefore use SDD data for the majority of analyses and will supplement these with data from ASH-Y and STS where appropriate (for example, to compare 16- to 18-year-olds with 11- to 15-year-olds given SDD is restricted to this latter age group, or where additional questions were asked).

Trial and use in young people in England

Vaping and smoking prevalence

Table 5 presents the most recent data on vaping prevalence among young people in England. The 2018 SDD data (11- to 15-year-olds) estimate current vaping prevalence at 5.9%, higher than current smoking prevalence which they estimate at 5.0%. ASH-Y (11- to 18-year-olds, but smaller sample size) estimate current vaping prevalence to be 4.8% and current smoking prevalence to be 6.3% (ASH-Y). The STS data are more recent but present data from a smaller sample (n=239) for 16- to 17-year-olds: 0.6% for vaping and 8.8% for smoking – the low estimate of 0.6% current vaping prevalence in

the STS survey must be considered in the light of the small sample size of that survey (n=239). Smoking prevalence was therefore higher than vaping prevalence in both ASH-Y and STS surveys in contrast to the SDD.

SDD data indicate that vaping prevalence was similar in 2016 and 2018 (6.2% and 5.9%). ASH-Y data indicate that current vaping among young people in England has risen since 2014, from 1.7% to 4.8%. More than three-quarters of participants in the SDD and ASH-Y surveys (75.3% and 83.6%) reported that they had never tried vaping; compared with 83.8% and 79.7% who reported that they had never tried smoking respectively.

In the SDD data, 3.6% of young people were former vapers, and 2.8% were former smokers, suggesting that more young people may have stopped vaping than have stopped smoking.

Table 5: Current smoking and vaping prevalence among young people in 3 national surveys; England, 2014 to 2019 (weighted data)

Survey	SDD 2014 England	SDD 2016 England	SDD 2018 England	ASH-Y 2014 England	ASH-Y 2015 England	ASH-Y 2016 England	ASH-Y 2017 England	ASH-Y 2018 England	ASH-Y 2019 England	STS 2018 England	STS 2019 England
Age	**11 to 15**	**11 to 15**	**11 to 15**	**11 to 18**	**11 to 18**	**11 to 18**	**11 to 18**	**11 to 18**	**11 to 18**	**16 to 17**	**16 to 17**
Vaping status											
Never tried	78.1	74.8	75.3	90.9	93.9	87.8	83.2	82.8	83.6	-	-
Tried only	14.3	15.3	15.3	7.1	4.7	9.3	10.9	12.3	9.4	-	-
Former	3.6	3.7	3.6	-	-	-	1.7	0.8	0.9	-	-
Current	4.0	6.2	5.9	1.7	1.2	2.5	3.5	3.5	4.8	2.1	0.6
Smoking status											
Never tried	81.8	81.0	83.8	77.7	77.1	80.3	76.9	78.6	79.7	-	-
Tried only	10.2	9.8	8.4	10.9	11.7	9.7	10.7	10.2	9.0	-	-
Former	2.5	2.8	2.8	2.8	3.0	3.3	3.6	3.5	3.4	-	-
Current	5.6	6.4	5.0	7.0	7.1	5.2	7.8	6.1	6.3	8.9	8.8
Unweighted sample size	6,022	11,684	13,191	1,625	1,926	1,999	2,260	2,011	2,173	281	239

Notes: SDD: 'Current' smoking included those who smoked more than once per week and those who smoked sometimes, but less than once per week. 'Current' vapers included 'regular' users who use vaping products more than once per week and 'occasional' users who vaped sometimes, but less than once per week.
ASH-Y: 'Current' smoking comprises those who smoked less than one cigarette per week, between 1 and 6 cigarettes per week, and more than 6 cigarettes per week. "Current" vaping excluded those who had only tried vaping once or twice but included those who vaped no more than once per month through to those vaping daily.
**STS:** Data up to November 2019; 'Current' cigarette smokers were those saying that they smoked every day or that they smoked but less than daily. 'Current' vaping was current use for any reason.

The SDD and ASH-A data both suggest that older youth are more likely to have tried vaping (Figures 1 and 2). STS only collects information from people aged 16 and 17, so those data were not used in this analysis.

The SDD also finds that current vaping increases with age. At age 11, 6.5% of participants in the SDD survey had ever vaped and just 0.4% were current vapers, but by age 15, 40.5% of participants reported ever vaping and 11.3% were current vapers, a definition that includes people who vape weekly as well as occasional vapers who vape less than weekly. Regular vaping (ie. those who vape weekly, or more often) among 15-year-olds, was estimated at 3.9% in the SDD survey, an estimate that is below the estimates for current adult vaping prevalence explored in Chapter 4. However, cross-survey comparisons must be made with caution due to the differing definitions of vaping used.

The ASH-Y data reported that 5.6% of people aged 11 had ever tried vaping compared to 33.6% of 18-year-olds (Figure 2). The ASH-Y data allow more detailed analysis than the SDD data and suggest that, although current vaping is higher among older (ie. 14 and 15) than younger (ie. 11- and 12-year-olds) adolescents, rates of vaping on a weekly or daily basis remain low overall. The proportion of young people who vaped more than weekly was 0.6% for 11-year-olds and 2.2% for 18-year-olds, and there is little difference across 16- to 18-year-olds, and small proportions of these age groups report being former vapers, which was not evident in the younger age groups. These analyses offer different perspectives, but also differing estimates of prevalence. These can by partially explained by the different sample sizes included and different methodologies used for collecting the data across the surveys.

Figure 1: Current and ever vaping prevalence by age among young people aged 11 to 15; England, 2018 (SDD, weighted data)
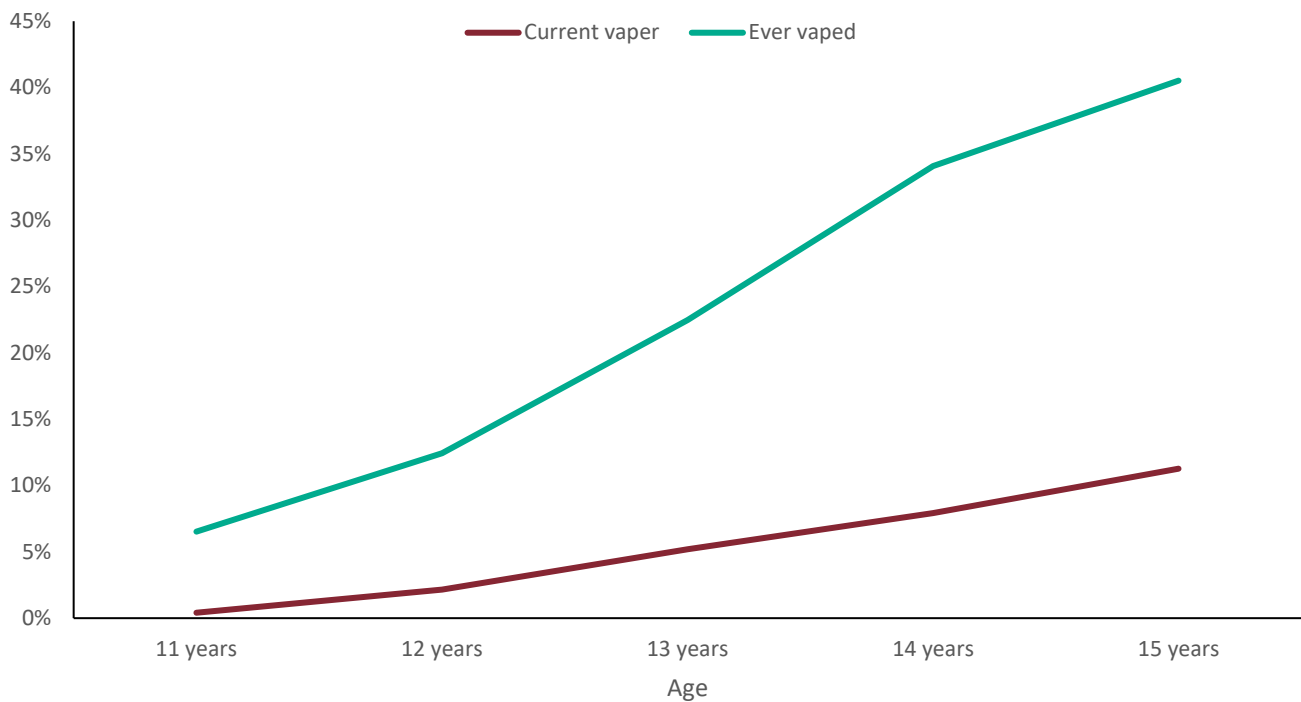
Notes: Unweighted base = 13,191

'Current' vaper included "regular users who vaped more than once per week" and "occasional users who vaped sometimes, but less than once per week". 'Ever vaped' included "current vapers, those who have only tried vaping and those who identify as former vapers".

Figure 2: Vaping status by age among young people aged 11 to 18; England, 2019 (ASH-Y, weighted data)
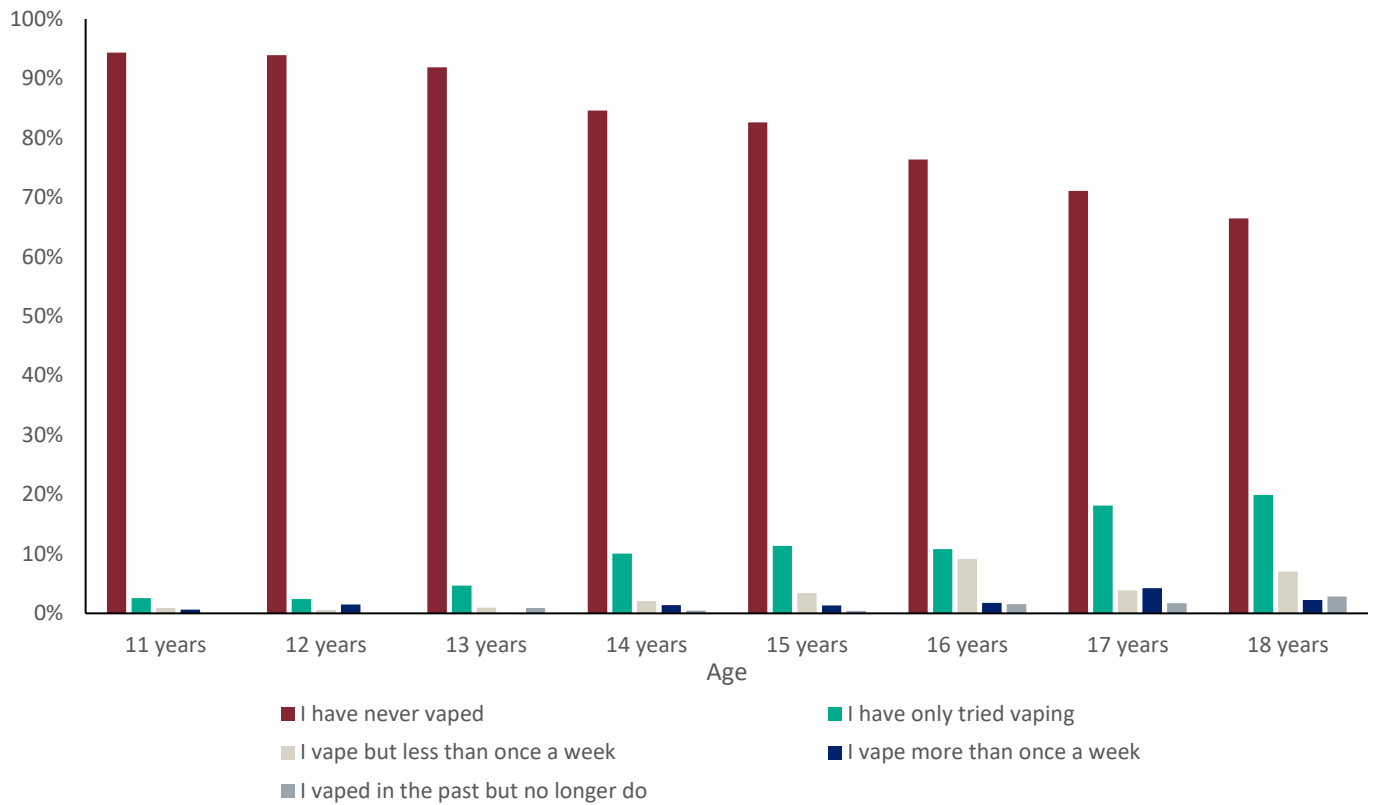
Notes: Unweighted bases: Overall = 2,040: By age: Age 11 = 123; age 12 = 214; age 13 = 209; age 14 = 206; age 15 = 243; age 16 = 194; age 17 = 403; age 18 = 448.

Figure 3 shows data from the SDD on smoking prevalence in people aged 11 to 15 years and illustrates the decline in smoking prevalence over the past 36 years. Smoking prevalence among 11- to 15-year-olds fluctuated in the 1980s and 1990s, but overall has fallen from a high of 22% in 1984 and has more than halved in the past 10 years, falling from 11% in 2008 to 5% in 2018 (Figure 3). In 2018, the SDD indicated that 5% of 15-year-olds were regular smokers (7% in 2016, 8% in 2014) – this is one of the ambitions specified in the Tobacco Control Plan for England (see Chapter 1). Figure 4 uses STS data in people aged 16 to 17 years and plots smoking prevalence since 2007, when smoking prevalence was estimated at 23.1% (95% CI 19.7-26.4). The most recent data from November 2019 estimate this figure at 8.8% (95% CI 4.9-12.6). Smoking prevalence in ASH-Y surveys (not displayed here) has fluctuated inconsistently since 2014, averaging between 5.2 and 7.6%.

Figure 3: Cigarette smoking prevalence among people aged 11 to 15; England, 1982 to 2018 (SDD, weighted data from 2010 onwards)

Notes: Survey was conducted yearly except for between 1982 and 1992; 1994 and 1998; and 2014 and 2018
Unweighted bases: 1982 = 2,979; 1984 = 3,658; 1986 = 3,189; 1988 = 3,018; 1990 = 3,121; 1992 = 3,295; 1993 = 3,140; 1994 = 3,045; 1996 = 2,854; 1998 = 4,723; 1999 = 9,333; 2000 = 7,061; 2001 = 9,277; 2002 = 9,796; 2003 = 10,260; 2004 = 9,618; 2005 = 9,092; 2006 = 8,152; 2007 = 7,738; 2008 = 7,750; 2009 = 7,612; 2010 = 7,254; 2011 = 6,446; 2012 = 7,538; 2013 = 5,121; 2014 = 6,084; 2016 = 11,897; 2018 = 13,472.
Prevalence is for current smoking, which included people who smoked more than once per week, and people who smoked sometimes, but less than once per week.

Figure 4: Cigarette smoking prevalence among people aged 16 to 17; England, 2007 to 2019 (STS, weighted data)
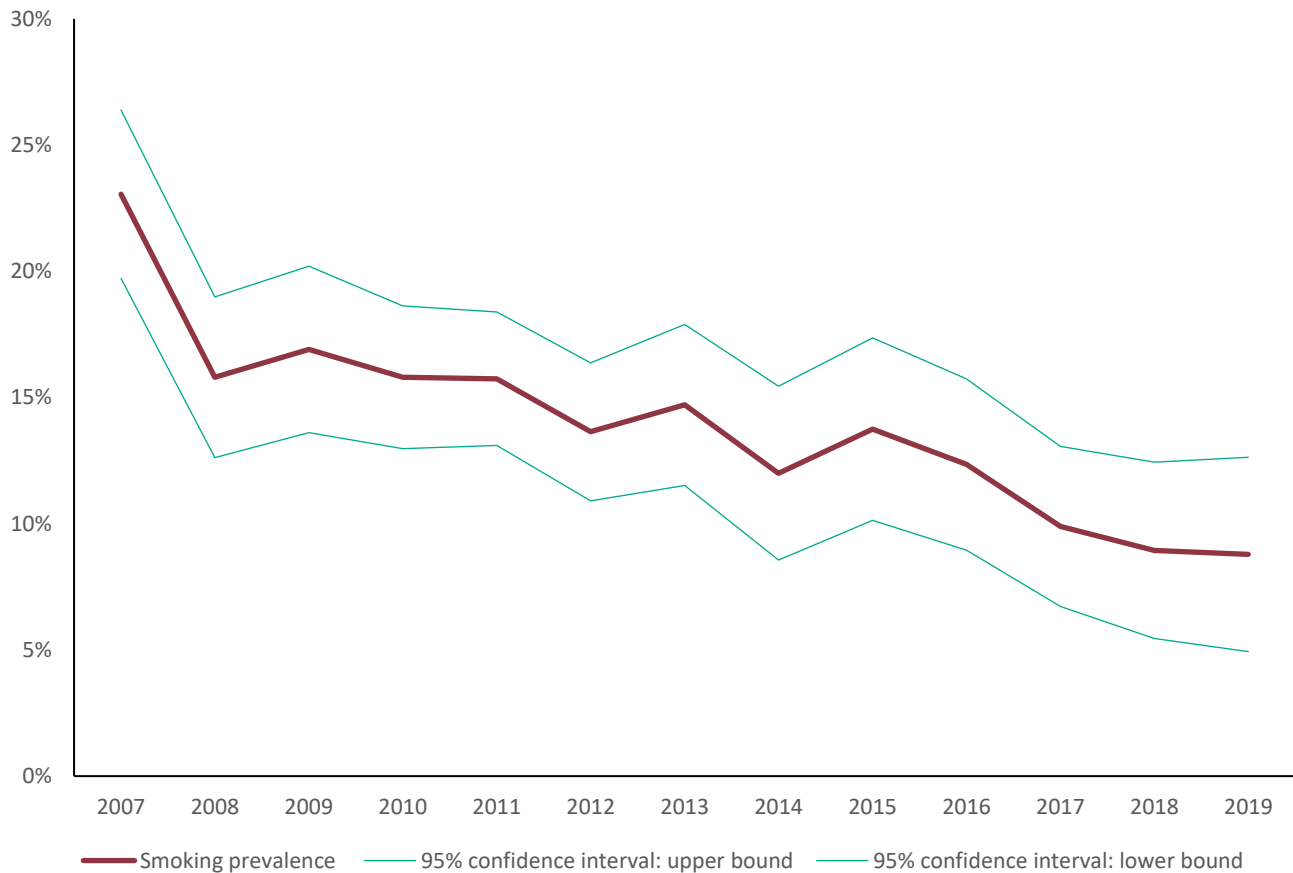
Notes: Unweighted bases: 2007 = 502; 2008 = 397; 2009 = 401; 2010 = 524; 2011 = 579; 2012 = 498; 2013 = 509; 2014 = 394; 2015 = 384; 2016 = 370; 2017 = 344; 2018 = 281; 2019 (to November) =239.
Current cigarette smokers were defined as those who smoked daily or less than daily.

Vaping in young people was most prevalent among regular smokers and rare among never smokers. Regular vaping among regular smokers (ie. both vaping and smoking more than once per week) was relatively common with 29.5% of regular smokers in the SDD survey saying that they vaped regularly (Figure 5). It is important to note that regular smokers comprised around 2% of the overall sample, so the absolute numbers of dual users remain small. The ASH-Y survey data (Figure 6) also explored dual use and show that current vaping was reported by 41.9% of current smokers (a figure that includes regular smokers as well as occasional smokers who smoked less than once per week). Among all young people who had tried smoking, 46.0% (SDD) and 31.8% (ASH-Y) had also tried vaping.

Vaping among those who do not smoke was rare, with less than 1% of never smokers in both the SDD and ASH-Y surveys identifying as regular vapers.

Figure 5: Vaping status by smoking status among young people aged 11 to 15; England, 2018 (SDD, weighted data)
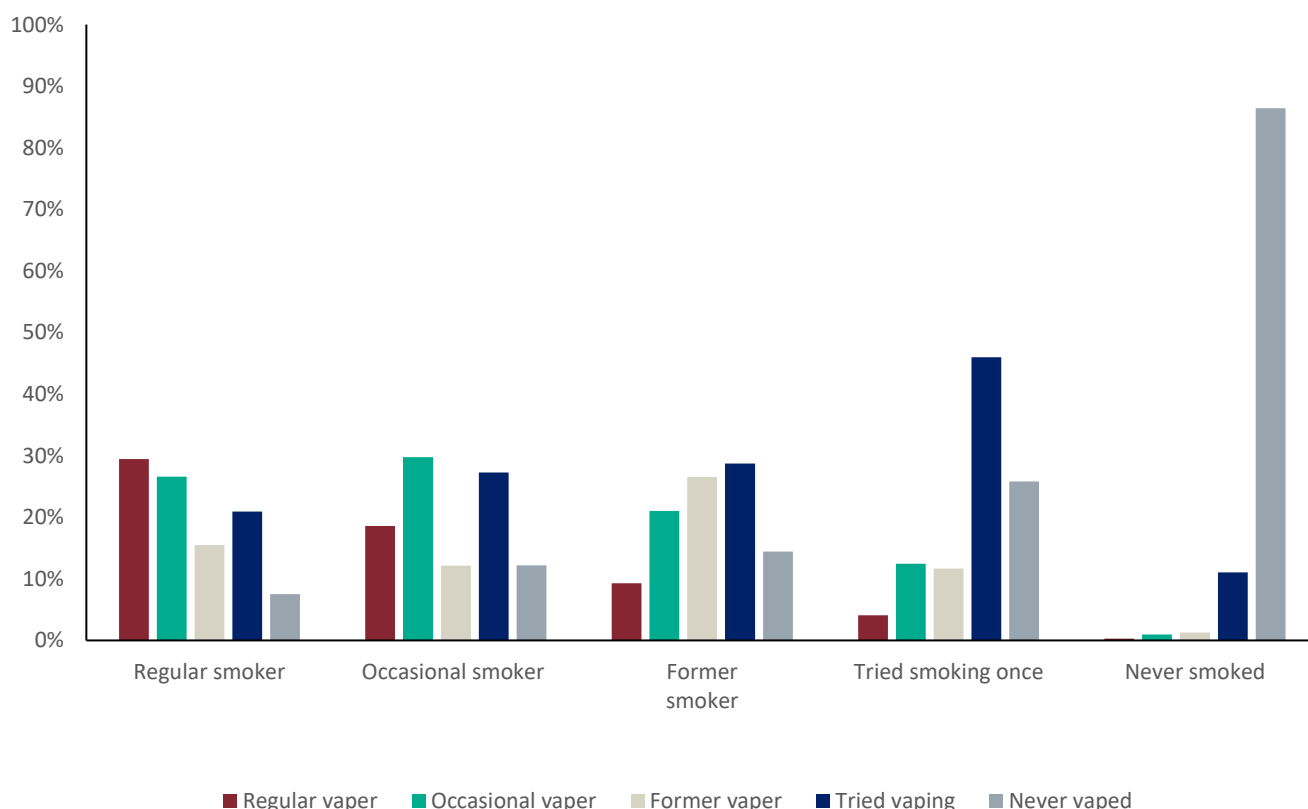
Notes: Unweighted base = 10,962.
Regular vaping or smoking refers to those who vape or smoke more than once per week; Occasional vaping or smoking refers to those who vape or smoke sometimes, but less than once per week.

Figure 6: Vaping status by smoking status among young people aged 11 to 18; England, 2019 (ASH-Y, weighted data)

■ I currently vape   ■ I have only tried vaping once or twice   ■ I vaped in the past but no longer do   ■ I have never vaped
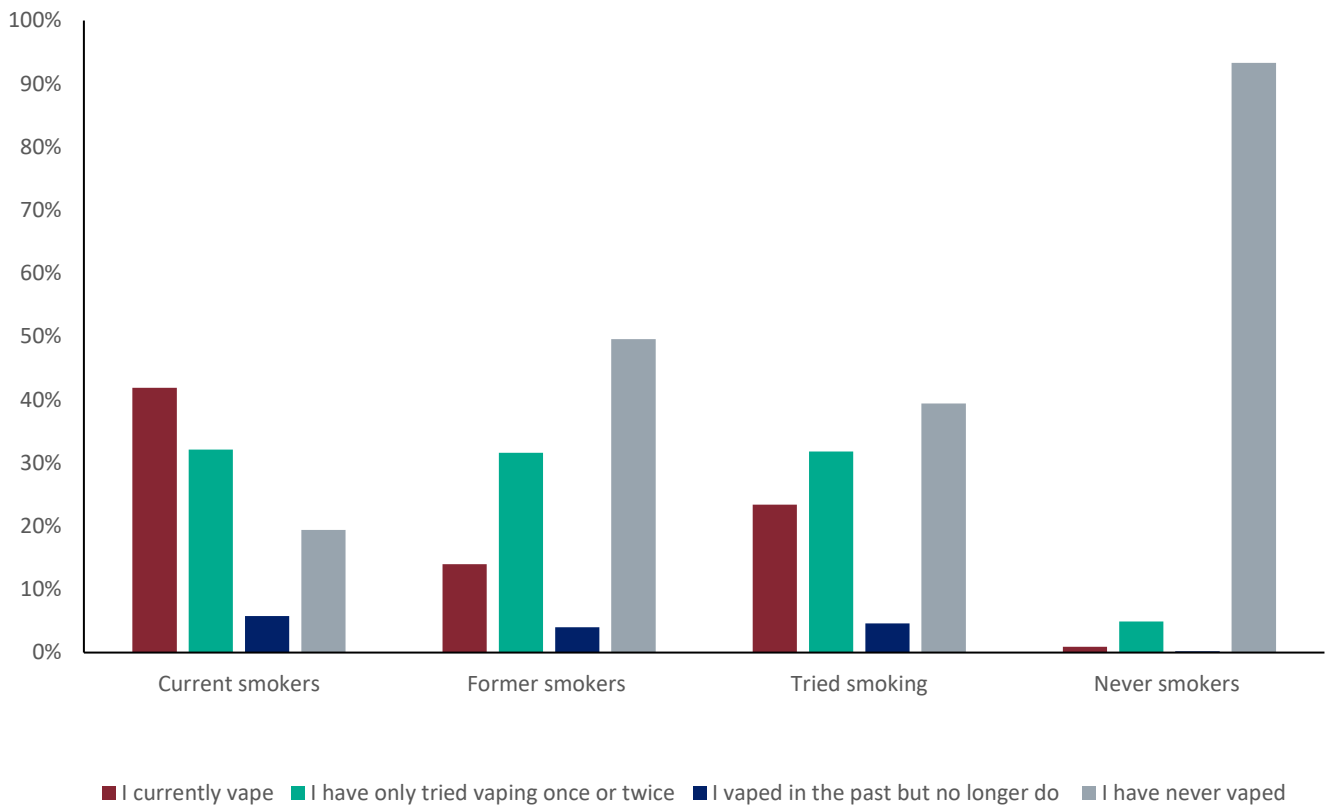
Notes: Unweighted base = 2,203.
Current vaping excludes those who had only tried vaping once or twice but includes those who vaped no more than once per month through to those who vaped daily.

Reasons for vaping

The most popular reason for vaping among young people both overall, and among never, former and current smokers was "just to give it a try" (ASH-Y data – Figure 7). There were however differences in the reasons given, with 70.6% of never smokers selecting "just to give it a try", but 35.1% of current smokers. The second and third most popular reasons for vaping were "I liked the flavours" (16.9% among current smokers and 10.4% among never smokers) and "other people use them, so I join in" (11.6% among current smokers and 10.9% among never smokers). When the reasons for trying vaping that related to smoking cessation or substitution were combined, 21.1% of current smokers used vaping products in place of, or to quit smoking. Under 1 in 10 (9.7%) of current smokers said they vaped because they enjoyed the experience, and 1.8% reported being addicted to vaping. Under 1% of all young people said they used vaping products because they "look cool". Again, the limitations of the small sample size here (n=396) must be acknowledged. Our understanding of why young people use vaping products would benefit from inclusion of similar measures to those reported here in larger surveys such as SDD.

Figure 7: Reasons for vaping by smoking status among young people who have ever tried vaping aged 11 to 18; England, 2019 (ASH-Y, weighted data)
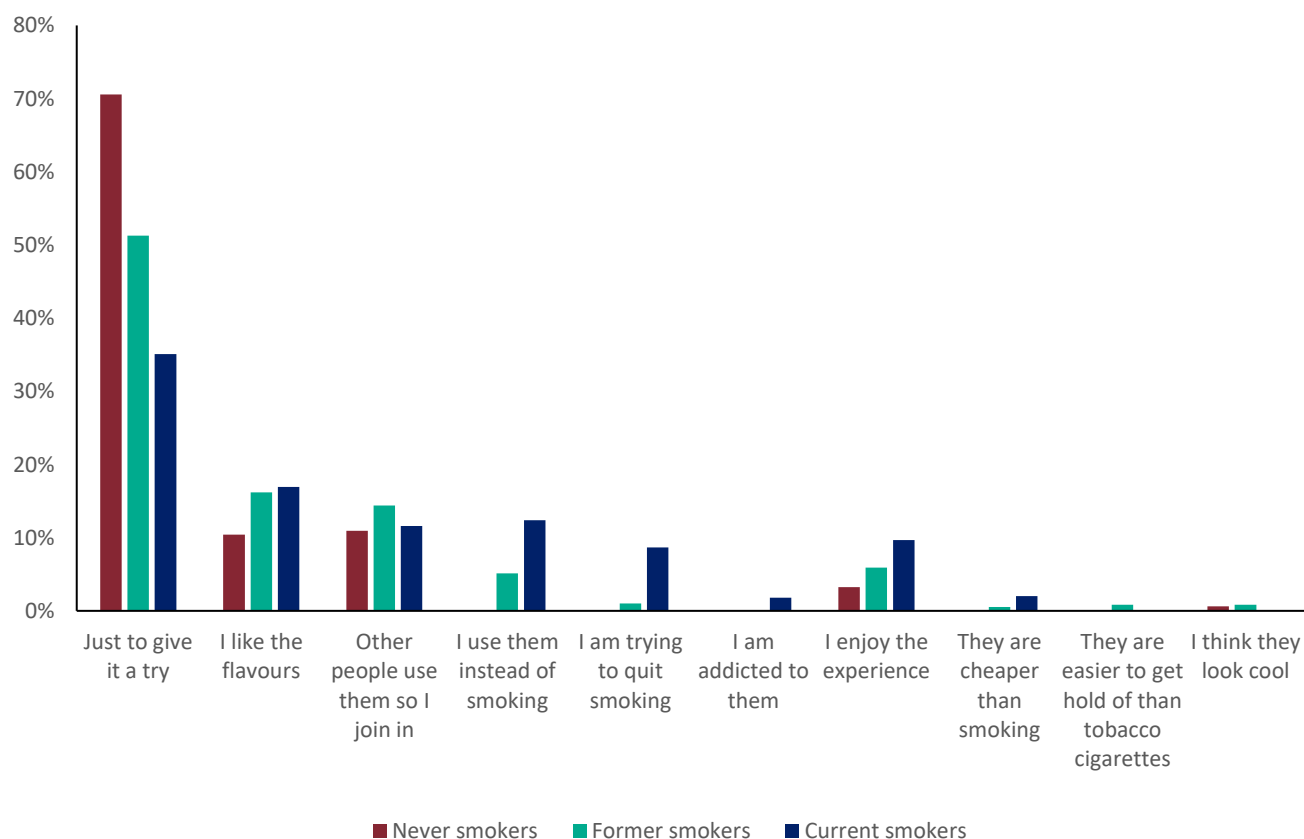
Notes: Unweighted base = 396.
Current smoking includes those who smoke less than once cigarette per week, between 1 and 6 cigarettes per week, and more than 6 cigarettes per week.

The order in which young people had tried smoking and vaping was tracked in the ASH-Y surveys (Figure 8). In 2019, just under half (47.6%) of young people who tried vaping did so having tried smoking first. This figure fell between 2014 when nearly 70% of vapers had tried smoking first and 2018 when it was 44.7%, but this fall may have stalled since 2018 (in 2019 it was 47.6%). The proportion of young people who tried vaping before smoking has risen from 7.5% in 2014 to 17.8% in 2019. The proportion of young people who had tried vaping but who had not tried smoking was 18.8% in 2014 and had increased to 30.0% in 2016 and 28.9% in 2019.

Figure 8: Order of first use of cigarettes and vaping products among young people aged 11 to 18 who have tried vaping; England, 2014 to 2019 (ASH-Y, weighted data)

Legend:
- I tried smoking a real cigarette before I first tried vaping
- I tried vaping before I first tried smoking a real cigarette
- I have never smoked a real cigarette but have tried vaping
- I don't remember
- Don't want to say
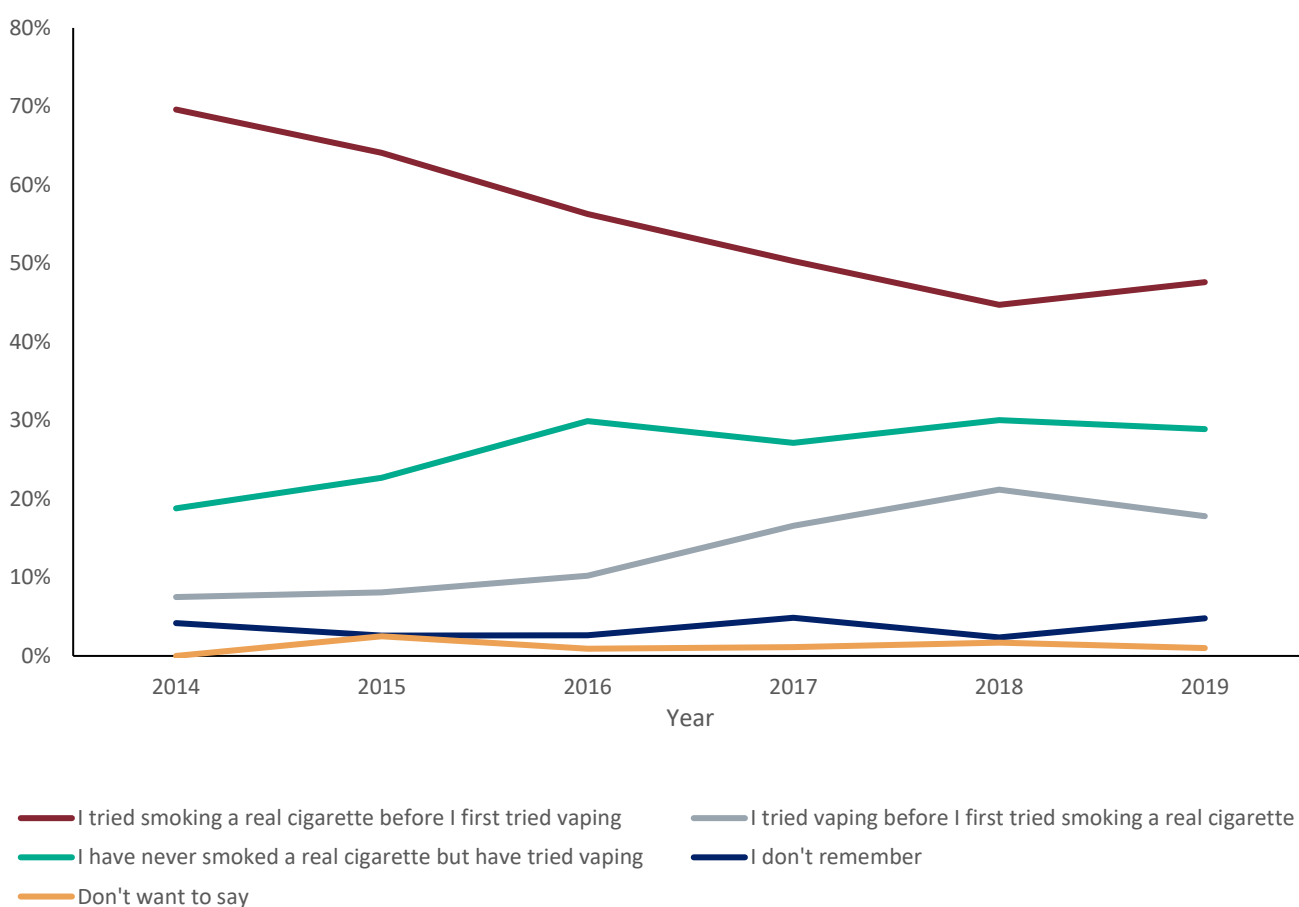
Notes: Unweighted bases: 2014 = 138; 2015 = 268; 2016 = 318; 2017 = 374; 2018 = 365; 2019 = 396.

Vaping products and place of purchase

The most popular vaping product among young people in England was a rechargeable device with a reservoir or tank that can be re-filled with e-liquid, a system preferred by nearly two-thirds (62.4%) of ASH-Y participants in 2019 (Figure 9). Just 6.2% preferred to use disposable and rechargeable vaping products whereas 17.6% preferred vaping products with pre-filled cartridges, up from the 11.1% who preferred this type of vaping

product in 2016 but lower than the 35.9% of young people who preferred this type of vaping device in 2015. It is important to note that the number of participants who answered this question in each year was small (eg. in 2015, n=26), so those results should be viewed with caution.

Figure 9: Type of vaping product used among young people who currently vape aged 11 to 18; England, 2015 to 2019 (ASH-Y, weighted data)
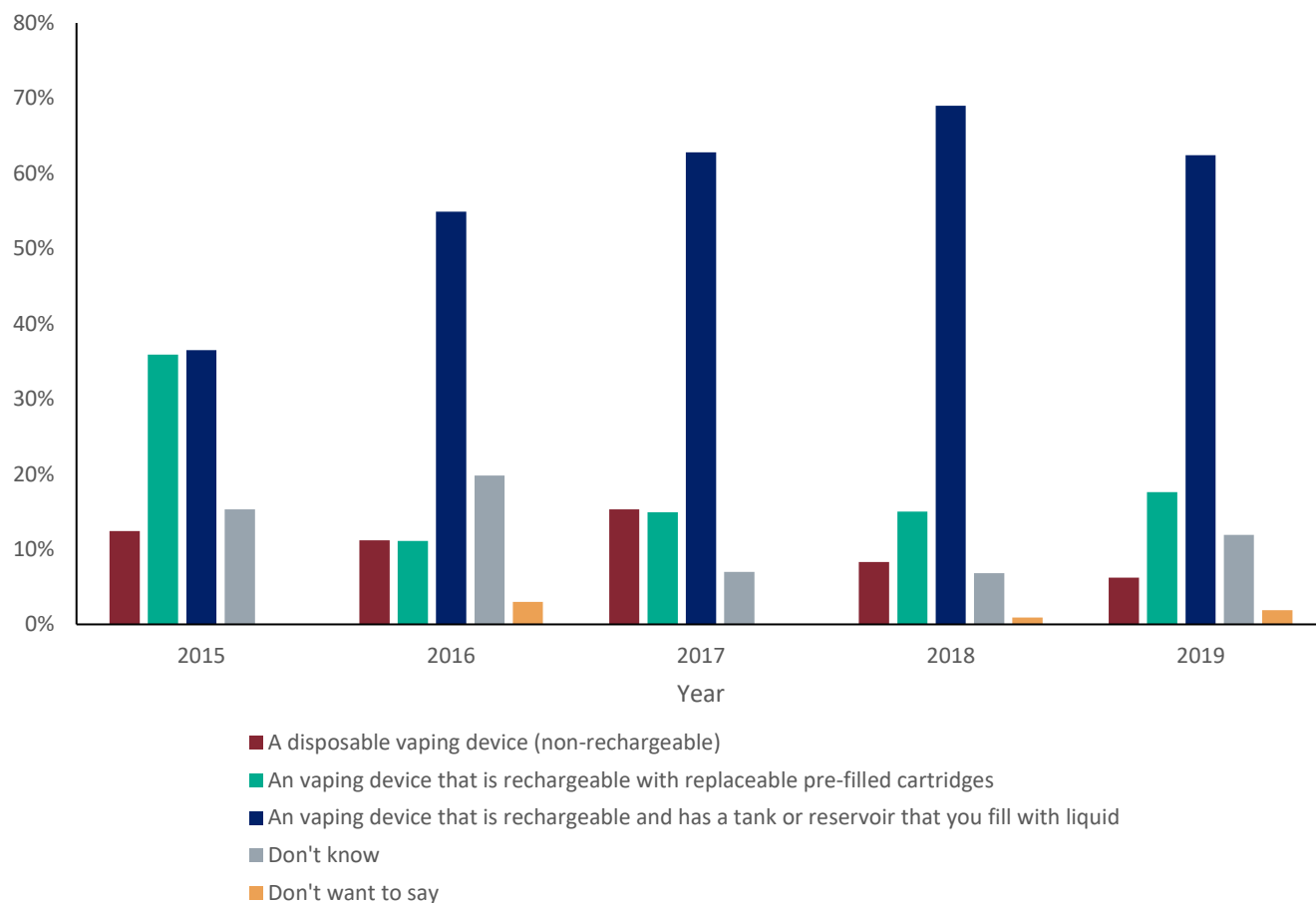
Notes: Unweighted bases: 2015 = 26; 2016 = 57; 2017 = 82; 2018 = 77; 2019 = 119 (no data on device type available for 2014). Current vapers does not include those who had only tried vaping once or twice but includes those who vaped no more than once per month through to those who vaped daily.

In 2019, the ASH-Y survey asked all 149 current or past vapers if they used nicotine in their vaping products. The results indicated that the majority of 11- to 18-year-old current or past vapers at least sometimes used nicotine in their vaping product (32.3% most often or always, 36.0% sometimes), with 20.4% saying they never contained nicotine and 11.3% saying they did not know. Questions on flavours were not asked in 2018 and 2019 but will be asked in 2020.

The SDD data suggest that in 2018 over half of regular vapers (aged 11- to 15-years) were given vaping products by other people (Figure 10). Forty-one percent said they

purchased from people, 29% said they purchased from shops and 29% from the internet in 2018. There were some small fluctuations since 2016.

Figure 10: Usual source of vaping product by year among regular vapers; England, 2016 and 2018 (SDD, weighted data)
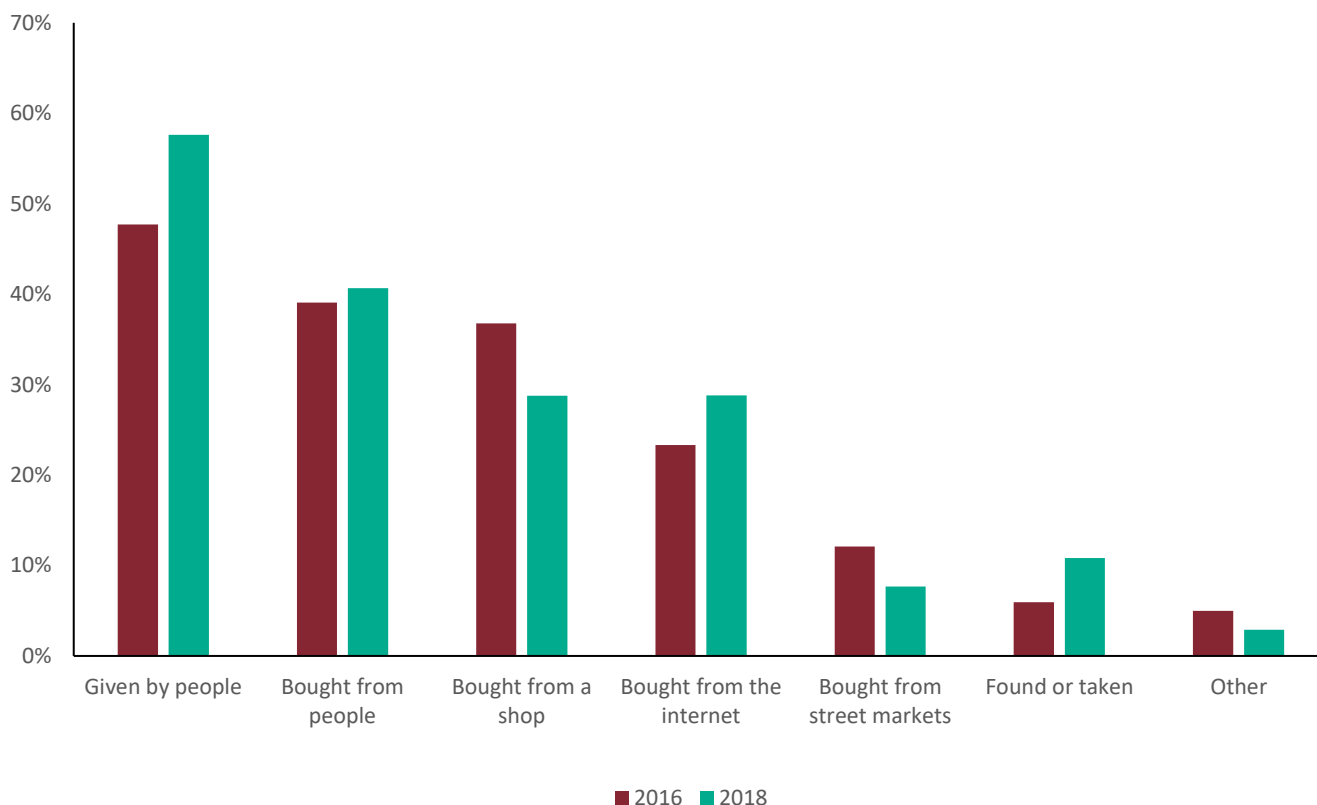
Notes: Unweighted bases 2016 = 311, 2018 = 269. Regular vaping defined as those who vape more than once per week.

The ASH-Y survey data suggest that nearly two-thirds of 11- to 17-year-olds who were current vapers (vaped more than once a month) bought vaping products themselves with the remaining one-third saying that they were given vaping products by someone they know. Figure 11 presents the locations from which current vapers aged under 18 (who are too young to legally buy vaping products in the UK) purchased vaping products, for 11- to 15-year-olds and 16- to 17-year-olds separately. The numbers responding to this question were very low (n=93) and so these data should be treated with caution. Additionally, participants could select more than one option.

Just under a third of current vapers bought their products from a newsagent, a figure that was similar between 11- to 15-year-olds and 16- to 17-year-olds. Just under a quarter (24.4%) of 11- to 15-year-olds bought vaping products from the supermarket, compared to 10.0% of older children, although it is worth noting that the figure of 24.4% represents just 10 participants aged between 11 and 15. The most substantial difference was seen in those young people who bought vaping products from street markets (19.5% for 11- to 15-year-olds and 0.0% for 16- and 17-year-olds); similarly

buying vaping products from someone at school was substantially more popular among people in the younger age groups, but possibly because people belonging to the older age groups were no longer at school. Just under 10% of 11- to 15-year-olds bought their devices online, compared to 2% of the, older, 16- to 17-year-olds.

Figure 12 displays the source of vaping products in cases where they were given to young people rather than purchased. Just under a half of current vapers reported being given vaping products by friends. No participants aged 11 to 15 were given vaping products by their parents whereas 6.1% of 16- and 17-year-olds said their parents had given vaping products to them.

Figure 11: Sources of vaping product which were purchased by current vapers aged 11 to 17; England, 2019 (ASH-Y, weighted data)
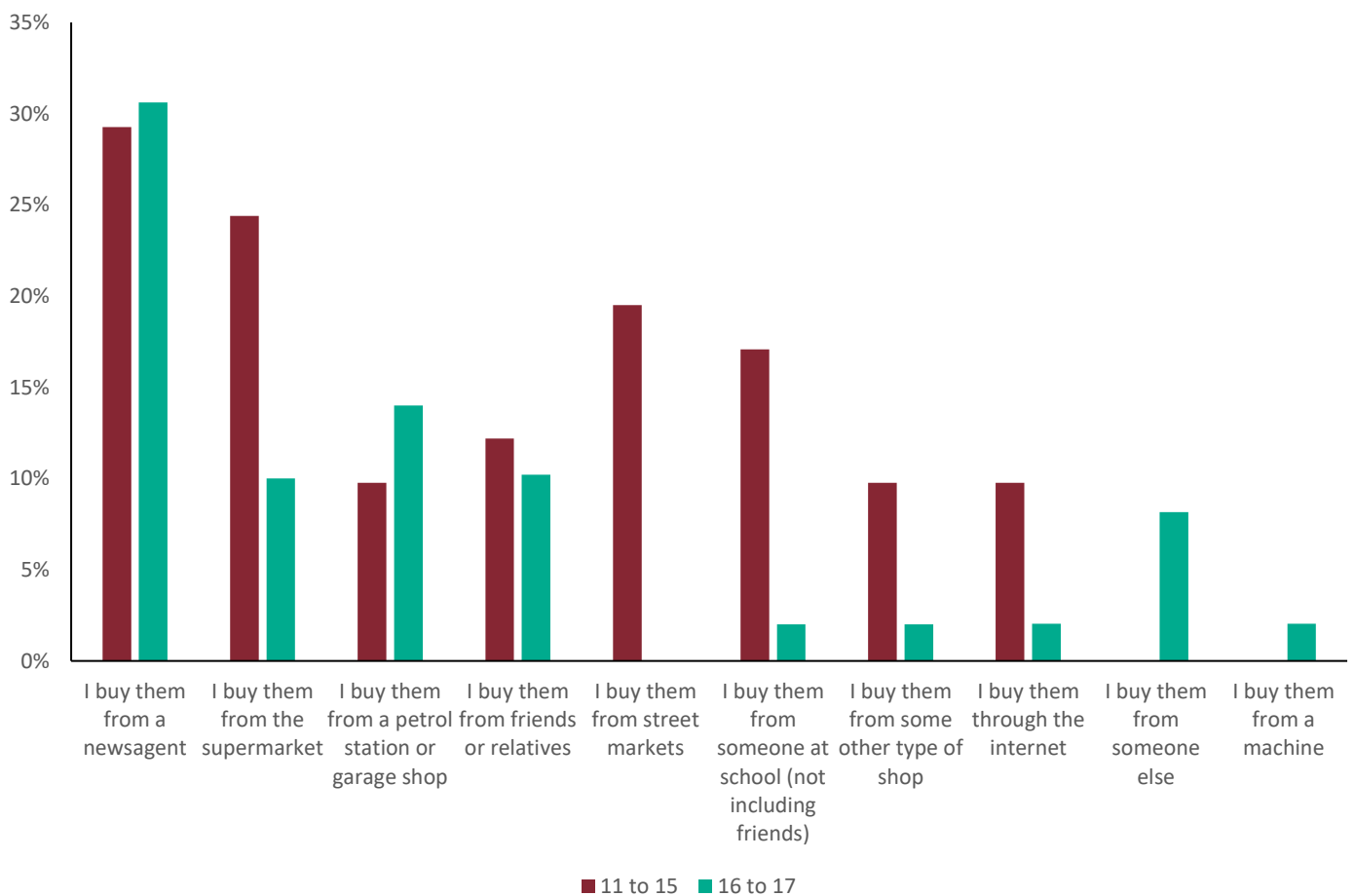
Notes: Unweighted base (for both those who bought and those who were given vaping products) = 93 (11 to 15 = 32; 16 to 17 = 61). Participants could select more than one option so totals will not sum to 100%. Current vapers does not include those who had only tried vaping once or twice but does include those who vaped no more than once per month through to those who vaped daily.

Figure 12: Sources of vaping products given to current vapers aged 11 to 17; England, 2019 (ASH-Y, weighted data)
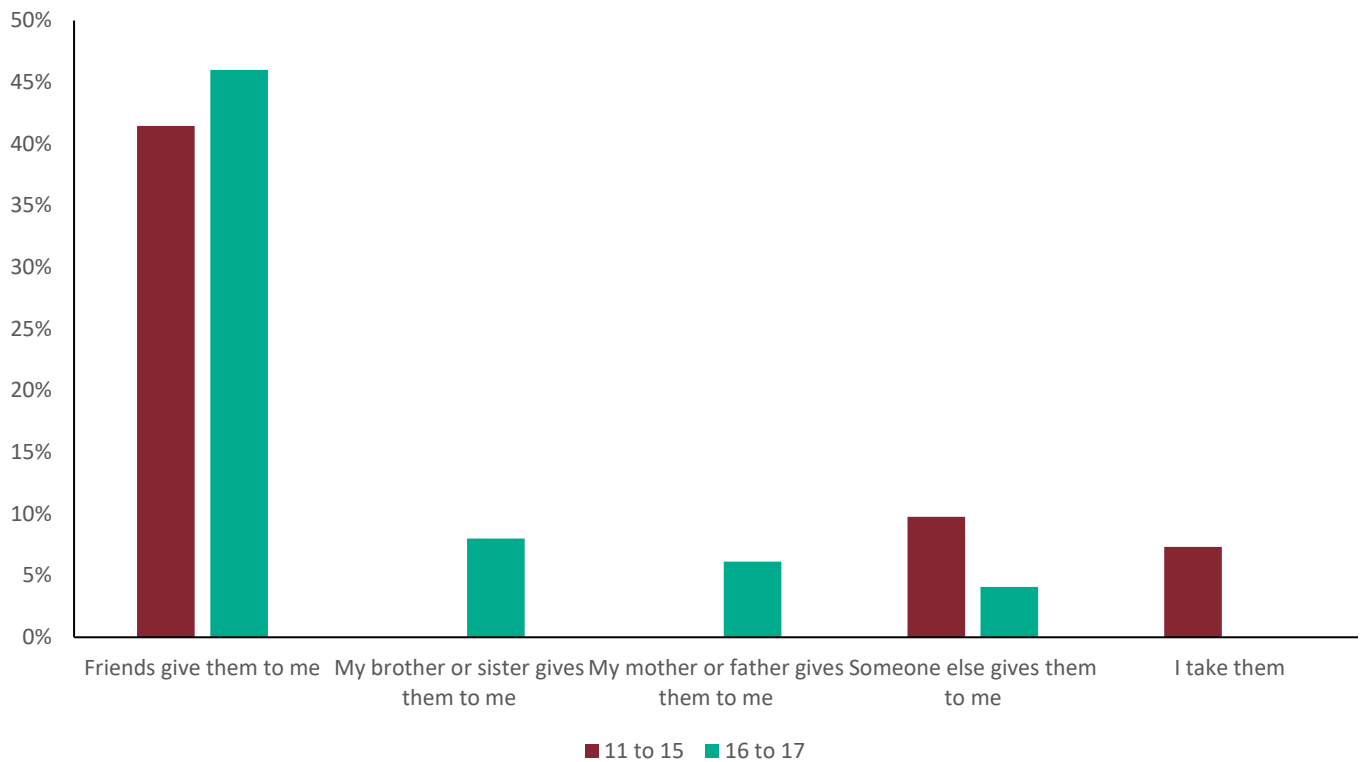
Notes: Unweighted base (for both those who bought and those who were given vaping products) = 93 (11 to 15 = 32; 16 to 17 = 61). Participants could select more than one option so totals will not sum to 100%.
Current vapers do not include those who had only tried vaping once or twice but does include those who vaped no more than once per month through to those who vaped daily.

Harm perceptions

The SDD survey explored young people's perceptions about the harms of vaping by asking participants whether they thought it was OK to try vaping, and whether it was OK to vape once per week. Just over a third (36.5%) thought it was OK to try vaping and just under a quarter (23.7%) thought it was OK to vape once per week.

More detailed data on harm perceptions among young people about vaping were recorded by the ASH-Y and STS surveys. The ASH-Y data are presented here because of the larger sample size of that survey. These results suggest, among young people who had heard of vaping, the proportion who thought that vaping products were more harmful than cigarettes remained very low at 3.2% (Figure 13). The proportion of participants who thought that vaping was less harmful than cigarettes has declined from two-thirds in 2014 to just over a half in 2019. About 30% of young people thought that the harms from smoking and vaping were about the same, a proportion which has slightly increased over time.

Figure 13: Harm perceptions of vaping compared to smoking; England, 2016 to 2019 (ASH-Y, weighted data)
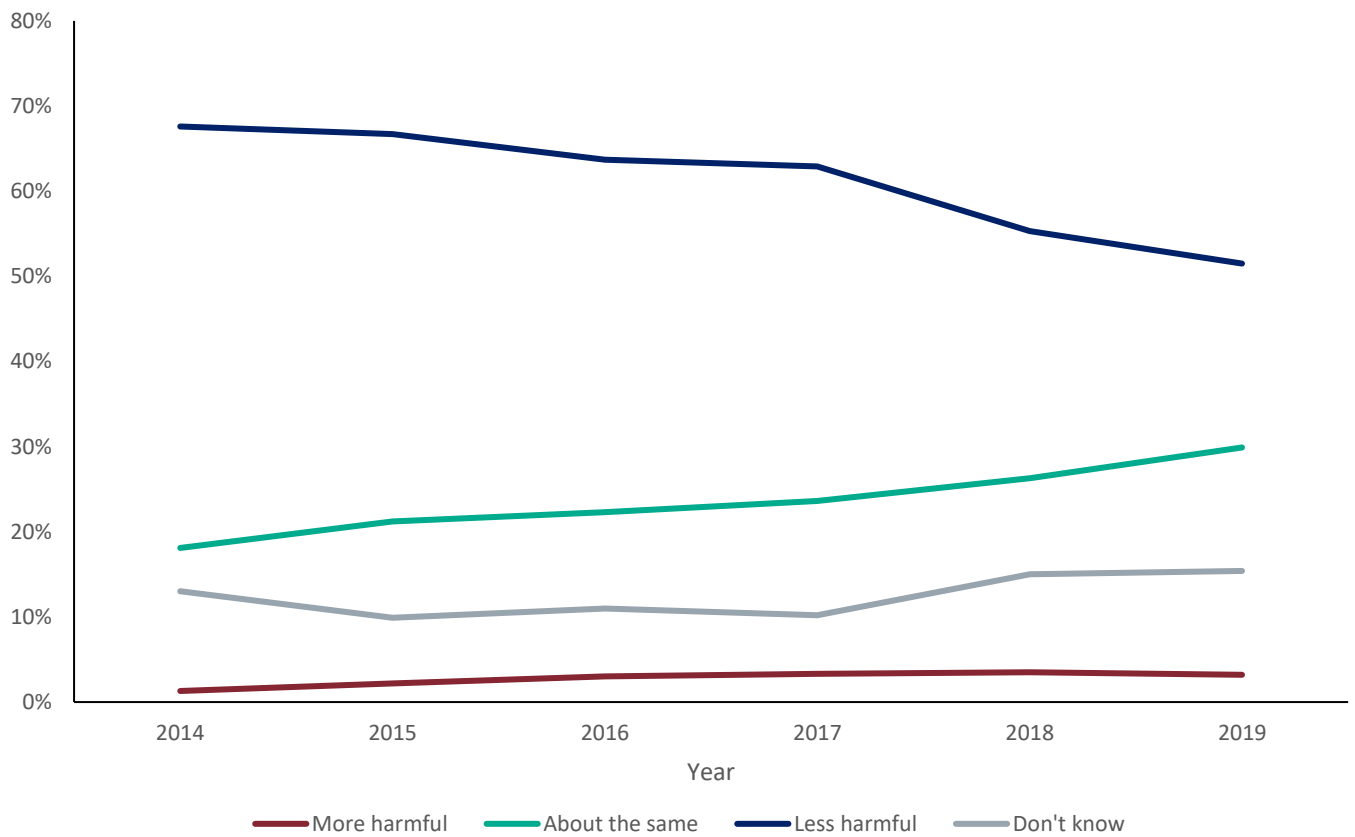
Notes: Unweighted bases: 2014 1,349; 2015 = 1,797; 2016 = 1,859; 2017 = 2,077; 2018 = 1,878; 2019 = 2,040

International literature review of vaping among young people

The international literature on vaping prevalence was screened and reviewed as described in Chapter 2. The data here are presented for the US in Table 6 and for the rest of the world in Table 7, because of the large number of research studies on vaping published in the US.

The search identified 15 studies that reported prevalence of current youth vaping in the US (Table 6). Five used data from the National Youth Tobacco Survey (NYTS), 3 used data from the Population Assessment of Tobacco and Health (PATH), 2 used the International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey, 2 used Monitoring the Future (MTF) and 3 used other surveys.

The most common measure was past 30-day vaping and the prevalence estimates for 2018 (the latest available in the published papers reviewed) ranged from 5% for middle school students (grades 6 to 8 − aged 11 to 14) to 21% for high school students (grades 9 to 12 − aged 14 to 18) [55-57] or 12th grade students (aged 17 to 18) [58]. In the same studies, smoking prevalence ranged from 1.8% past 30-day smoking in middle school [55, 56] to 8.1% in high school [59].

Data from the US NYTS, published by the Centers for Disease Control and Prevention (CDC) have indicated recent increases in vaping prevalence among US youth [60]. This rise has been referred to as a 'vaping epidemic' (eg. [61]). The data presented in Table 6 6 reflect these recent increases in vaping. An analysis of the 2018 NYTS data by Jarvis and colleagues [62] has suggested that uptake of vaping has been strongly associated with current smoking and that vaping prevalence is around 1% among never smokers. They also report that increases in vaping prevalence have not slowed the decline in smoking prevalence [62]. This reflects findings by Levy and colleagues [63] that reported an association between reductions in smoking prevalence and increases in vaping prevalence among US youth.

Hammond and colleagues (see below) report more modest increases for the US using ITC data than have been reported using NYTS data [64]. The US sample of the ITC survey consists of around 4,000 people aged 16 to 19 (~1,333 for each year of age) compared to the NYTS sample of around 20,000 people aged 11 to 18 (~2,500 for each year of age) and PATH which is around 12,000 people aged 12 to 17 (~2,000 for each year of age).

For all other countries, there were only 7 studies found that reported vaping prevalence among youth (Table 7). Hammond et al. presented data from Canada and England (as well as the US) [64], 2 studies presented prevalence data for Germany [65, 66], 2 for Mexico [67, 68] and one each for China [69] and South Korea [70]. Current or past

30-day use was highest in 16- to 19-year-olds in Canada at 14.6% in 2018 [64], and lowest in 12- to 17-year-olds in Mexico, at 1.1% in a study using data from 2016 [68].

The Hammond et al study used cross-sectional data from England, Canada and the US between 2017 and 2018 [64]. There were significant increases in vaping (past 30 days, past week and 15+ days in the past month) in Canada and the US between 2017 and 2018, while there were no significant increases in England (in line with evidence presented in this chapter). Of concern, in Canada there was an increase in past week vapers among never smokers. The use of JUUL increased in all 3 countries, particularly the US and Canada. There was a significant increase in smoking in Canada, a marginal increase in England in regular smokers (not seen in data reported in this chapter), with no change in the US.

Table 6: Peer-reviewed studies that reported youth vaping prevalence in the US

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Hammond et al., 2018 [71]	Age 16 to 19	International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey 2017	Past 30 days use: 14.2%			
Hammond et al., 2019 [64]	Age 16 to 19	International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey 2017, 2018	Ever 2017: 31.3% 2018: 33.6% Past 30 days 2017: 11.1% 2018: 16.2% Past week 2017: 6.4% 2018: 10.6% ≥15 days in past 30 days 2017: 3.0% 2018: 5.2%			Ever 2017: 32.3% 2018: 33.1% Past 30 days 2017: 11.0% 2018: 12.2% Past week 2017: 8.5% 2018: 8.8% ≥15 days in past 30 days 2017: 4.6% 2018: 5.1%
Miech et al., 2019 [72]	12th grade students	Monitoring the Future 2017	Vaped nicotine in past 30 days: 12.7% Vaped any substance in past 30 days: 19.0%			Smoked cigarettes in past 30 days: 9.6% Smoke large cigars, small cigars, and/or cigarillos in past 30 days: 13.0% Smoked hookah in past 30 days: 6.2%

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Miech et al., 2019 [58]	8th, 10th, 12th grade students	Monitoring the Future 2017, 2018	Vaped nicotine in past 30 days 2017: 8th grade: 3.5% 10th grade: 8.2% 12th grade: 11.0% Vaped nicotine or flavouring in past 30 days 2017: 8th grade: 6.3% 10th grade: 12.0% 12th grade: 15.2% Vaped nicotine in past 30 days 2018: 8th grade: 6.1% 10th grade: 16.1% 12th grade: 20.9% Vaped nicotine or flavouring in past 30 days 2018: 8th grade: 9.7% 10th grade: 20.3% 12th grade: 25.0%			

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Agaku et al., 2019 [73]	6th to 12th grade students	National Youth Tobacco Survey 2015, 2016	Vaped in past 30 days 2015 6th grade: 2.8% 7th grade: 4.9% 8th grade: 8.2% 9th grade: 12.3% 10th grade: 15.3% 11th grade: 17.2% 12th grade: 19.7% 2016 6th grade: 2.6% 7th grade: 3.6% 8th grade: 6.6% 9th grade: 8.7% 10th grade: 12.0% 11th grade: 11.4% 12th grade: 13.6%			Smoked cigarettes in past 30 days (2016) 6th grade: 1.4% 7th grade: 2.4% 8th grade: 2.7% 9th grade: 4.9% 10th grade: 7.3% 11th grade: 8.3% 12th grade: 12.3%
Cho et al., 2018 [70]	Age 9 to 21, 93.2% of those were 12 to 18	National Youth Tobacco Survey 2011 and 2015	Past 30-day use 2011: 0.9% 2015: 11.2%			Past 30 days: 2011: 11.1% 2015: 6.1%
Gentzke et al., 2019 [56] Cullen et al., 2018 [55] Kuehn, 2019 [57]	Middle and High school (age 11 to 18)	National Youth Tobacco Surveys 2011 to 2018	Past 30-day use 2017 High school: 11.7% Middle school: 3.3% 2018 High school: 20.8% Middle school: 4.9%			Past 30-day cigarette use High school: 8.1% Middle school: 1.8%
King et al., 2018 [74]	Age 13 to 17	Online survey, 2016	Past 30-day use: 4.5%			

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
McKeganey et al., 2019 [75]	Age 15 to 17	Online survey, 2018	Past 30-day JUUL use: 13 to 14 years: 0.8% 15 to 17 years: 4% Use of JUUL on 20 to 30 days of past 30 days: 13 to 14 years: 0% 15 to 17 years: 0.3%	Ever use of JUUL: 7.6%		Ever use 13 to 14 years: 9.6% 15 to 17 years18.1% Past 30-day use 13 to 14 years: 1.3% 15 to 17 years: 5.8% Frequent use 13 to 14 years: 0.3% 15 to 17 years:1%
McMillen et al., 2018 [76]	Age 12 to 17	Wave 1 (2013 to 2014) and Wave 2 (2014 to 2015) of the Population Assessment of Tobacco and Health (PATH) Study	Past 30-day vaping Wave 1: 3.1% Wave 2: 3.6% ≥1-day use in past 30 days Wave 1: 2.1% Wave 2: 2.8%.			Current smoker Wave 1: 4.6% Wave 2: 4.0% Ever smoker Wave 1: 8.7% Wave 2: 7.7%
Rezk-Hanna et al., 2019 [77]	Age 12 to 17	Wave 2 (2014 to 2015) PATH		E-cigarette: 14.3% E-hookah: 7.7%		
Stanton et al., 2019 [78]	Age 12 to 17	Wave 1 (2013 to 2014); Wave 2 (2014 to 2015) of PATH	Vaped in past 30 days Wave 1: 3.1% Wave 2: 3.6%	Ever vaped W1: 10.7% W2: 14.3%		Ever cigarette smoking Wave 1: 13.4% Wave 2: 11.7% Use of cigarette in past 30 days Wave 1: 4.6% Wave 2: 4%
Vallone et al., 2018 [79]	Age 15 to 17	Truth Longitudinal Cohort (TLC) 2018	Past 30-days JUUL use: 6.1%.	Ever use of JUUL: 9.5%		Current tobacco use: 7%

Table 7: Peer-reviewed studies that reported youth vaping prevalence in countries other than the US

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Canada	Hammond et al., 2019 [64]	Age 16 to 19	International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey 2017, 2018	Ever 2017: 29.3% 2018: 37.0% Past 30 days 2017: 8.4% 2018: 14.6% Past week 2017: 5.2% 2018: 9.3% ≥15 days in past 30 days 2017: 2.1% 2018: 3.0%			Ever 2017: 31.9% 2018: 36.6% Past 30 days 2017: 10.7% 2018: 15.5% Past week 2017: 7.6% 2018: 11.9% ≥15 days in past 30 days 2017: 4.8% 2018: 7.4%
England	Hammond et al., 2019 [64]	Age 16 to 19	International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey 2017, 2018	Ever 2017: 33.7% 2018: 32.7% Past 30 days 2017: 8.7% 2018: 8.9% Past week 2017: 4.6% 2018: 4.6% ≥15 days in past 30 days 2017: 2.0% 2018: 2.2%			Ever 2017: 40.4% 2018: 39.8% Past 30 days 2017: 15.6% 2018: 16.4% Past week 2017: 9.8% 2018: 11.3% ≥15 days in past 30 days 2017: 5.0% 2018: 6.4%
China	Xiao et al., 2018 [69]	Age 11 to 17	Global Youth Tobacco Survey	Past 30-day use: 1.2%			

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Germany	Kotz & Kastaun, 2018 [65]	Age 14 to 17	Deutsche Befragung zum Rauchverhalten (DEBRA) [German Study on Tobacco Use] 2016-17	Current use: 2.8%	16.4%		
Germany	Orth et al., 2018 [66]	Age 12 to 17	BzgA-Alkoholsurvey 2016	Past 30-day use: Boys: 4.6% Girls: 2.5% Past 30-day e-shisha use: Boys: 4.2% Girls: 2.9%			Past 30-day use: Boys: 9.8% Girls: 6.2% Current regular or occasional smoker: Boys: 10.1% Girls: 4.7%
Lithuania	Brożek et al., 2018 [80]	Age 19.8±1.3	YoUng People E-Smoking Study (YUPESS), 2017-2018	Vaping only: 1.4%, Overall frequency of vaping users: 3.6%	56.7%		Ever smoking: 73% Regular smoking: 14.9%
Mexico	Zavala-Arciniega et al., 2018 [68]	Age 12 to 17	National Survey of Drugs, Alcohol and Tobacco Use (ENCODAT) 2016	1.1%	7%		
Mexico	Zavala-Arciniega et al., 2019 [67]	Last year of middle school	School-based survey 2016 in selected cities	Past 30 days: 10.9% Mean days of use: Girls: 4.4 Boys: 7.3			
Poland	Brożek et al., 2018 [80]	Age 21.9±2.1	YoUng People E-Smoking Study (YUPESS), 2017-2018	Vaping only: 1.13%, Overall frequency of vaping users: 2.7%	45.0%		Ever smoking: 72% Regular smoking: 13.5%
Russia	Brożek et al., 2018 [80]	Age 20.4±2.2	YoUng People E-Smoking Study (YUPESS), 2017-2018	Vaping only: 1.4%, Overall frequency of vaping users: 4.0%	33.4%		Ever smoking: 59% Regular smoking: 12.3%
Serbia	Kilibarda et al., 2019 [81]	Age 13 to 15	Global Youth Tobacco Survey 2017	Past 30-day use: 6.2%			Past 30-day use: 11.0%
Slovakia	Brożek et al., 2018 [80]	Age 22.5±1.8	YoUng People E-Smoking Study (YUPESS), 2017-2018	Vaping only: 0.98%, Overall frequency of vaping users: 2.52%	34.4%		Ever smoking: 76.5% Regular smoking: 13.1%
South Korea	Cho et al., 2018 [70]	Age 12 to 18	Korea Youth Risk Behaviour Web-based Survey 2011 and 2015	Past 30-day use 2011: 4.7% 2015: 4.0%			Past 30 days: 2011: 12.1% 2015: 7.8%

Conclusions

Summary of findings

- current vaping prevalence (weekly or less than weekly) among young people in England has remained reasonably steady with the best recent estimates putting it at 6% of 11- to 15-year-olds in 2018 and 5% of 11-to-18-year-olds in 2019
- older children are more likely to vape. Current use among 11-year-olds was estimated at less than 1% in 2018 compared with 11% of 15-year-olds
- current vaping in mainly concentrated in young people who have experience of smoking. Less than 1% of 11- to 18-year-olds who have never smoked are current vapers
- no surveys reported much increase in vaping prevalence
- current smoking prevalence (weekly or less than weekly) among 11- to 15-year-olds halved between 2009 (11%) and 2018 (5%) but has remained relatively steady since 2014
- young people's perceptions of the relative harms of vaping compared with smoking are increasingly out of line with the evidence. The proportion of 11- to 18-year-olds who thought that vaping was less harmful than cigarettes declined from 68% in 2014 to 52% in 2019
- just over a third of 11- to 15-year-olds thought it was OK to try vaping and just under a quarter thought it was OK to vape once per week
- most young people who have tried vaping, do so from curiosity
- tank models, which are reusable, rechargeable kits that users can refill with liquid, remain the most popular device type used by young people
- recent UK surveys have not asked about the use of flavours among young people who vape
- almost 60% of 11- to- 15-year-olds who vaped regularly (more than once per week) reported being given vaping products, mostly by friends. But many also reported buying vaping products from other people, shops and the internet
- comparisons across countries are hampered by inconsistent questions and survey methods. One survey that compared vaping among 16- to 19-year-olds from 2017 to 2018 using consistent methods found lower levels of vaping in England compared to Canada and the US

Implications

- vaping and smoking prevalence among young people in England should continue to be closely monitored
- questions on flavour preferences and reasons for vaping among young people should be added to large nationally representative surveys
- enforcement of age of sale regulations needs to be improved

Chapter 4: Vaping among adults

Objective

This chapter summarises the up-to-date evidence on vaping prevalence among adults in England. It covers data on trial and current use of vaping products and summarises data on smoking for comparison. The chapter also presents data on the range of vaping devices used, the strength of vaping liquids, flavours, perceptions of harm, reasons for use and use of heated tobacco products. A summary of recent data from the stop smoking services and vaping in England is also presented. The chapter also summarises the international academic literature on vaping prevalence enabling comparisons to be made between England and other countries.

Surveys

This chapter focuses on data from 3 surveys: the Smoking Toolkit Study (STS), the ASH Smokefree Great Britain Survey (ASH-A), and the Opinions and Lifestyle Survey (OPN). The methods for each of these surveys are described in detail in Chapter 2 and Table 4. Data from the Annual Population Survey (APS) has been used to provide an estimate of smoking because of the large sample size and its use by the UK government to assess progress against the Tobacco Control Plan in England [34]; however, this survey did not report estimates of vaping prevalence and is therefore not referred to through the rest of the chapter. Of the remaining surveys, the STS (16+) has the largest sample size (18,862 from January to November 2019) and is therefore presented here where there is an option to do so. The ASH-A data (18+) are based on a 2019 survey of 12,393 people, and the OPN data (16+) are based on a 2018 survey of 8,303 people.

Trial and use in adults in England

Vaping and smoking prevalence

Estimates of smoking prevalence in England in 2019 were similar across surveys and ranged from 14.7% (ASH-A) to 15.4% (STS) (Table 8). The APS and OPN surveys present data from 2018 and reported smoking prevalence at 14.4% (APS) and 16.3% (OPN). Differences may be due to sample size or different age groups included.

Estimates of current vaping prevalence among adults in England across the surveys were consistently lower than the estimates for smoking prevalence and ranged from 5.3% (STS – 2019) to 7.2% (ASH-A – 2019). The lowest estimate is from STS where 16- and 17-year-olds were included. Figure 14 displays the prevalence of both smoking and vaping as reported by 3 national surveys over time, starting from between 2010 and 2014 (according to the availability of vaping data). Despite some differences between surveys, prevalence of vaping in adults appears to have risen slowly or has remained relatively stable since 2015 while prevalence of smoking continues to decline. Using the latest data on the population of England [82] it is possible to estimate that the number of current adult vapers in England is about 3.1 million. It is important to note that, if the prevalence of vaping remains unchanged, the absolute number of vapers in England will continue to rise as the population increases.

Table 8: Current smoking and vaping prevalence among adults in 4 national surveys; England, 2018 and 2019 (weighted data)

	APS 2018 Age 18+	OPN 2018 Age 16+	STS 2019 Age 16+	ASH-A 2019 Age 18+
Current smoking	14.4%	16.3%	15.4%	14.7%
Ever tried vaping	-	20.0%	-	19.4%
Current vaper	-	6.3%	5.2%	7.2%
Unweighted bases	152,816	6,619	18,862	10,338

Notes:
APS: Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays".
OPN: Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays". Current vaping is people who answered "yes, I currently use one" to a question about whether they had ever used e-cigarettes
ASH-A: Current smoking included people who smoked daily as well as those who smoked, but not daily. Ever tried included people who had tried vaping and those who continued to vape. Current vaping refers to people who had tried vaping and who still vaped, excluding those who no longer vaped.
STS: Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily. Current vaping was "current vaping for any reason". **STS** data available from January to November 2019

Figure 14: Current smoking and vaping prevalence among adults in 3 national surveys; England, 2010 to 2018 (weighted data)

Notes: Unweighted bases (for most recent year) OPN = 6,619; ASH-A = 10,338; STS = 18,875.
Ages: 16+ for OPN and STS, 18+ for ASH-A.
ASH-A: Current smoking included people who smoked daily as well as those who smoked, but not daily. Ever tried included people who had tried vaping and those who continued to vape. Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.
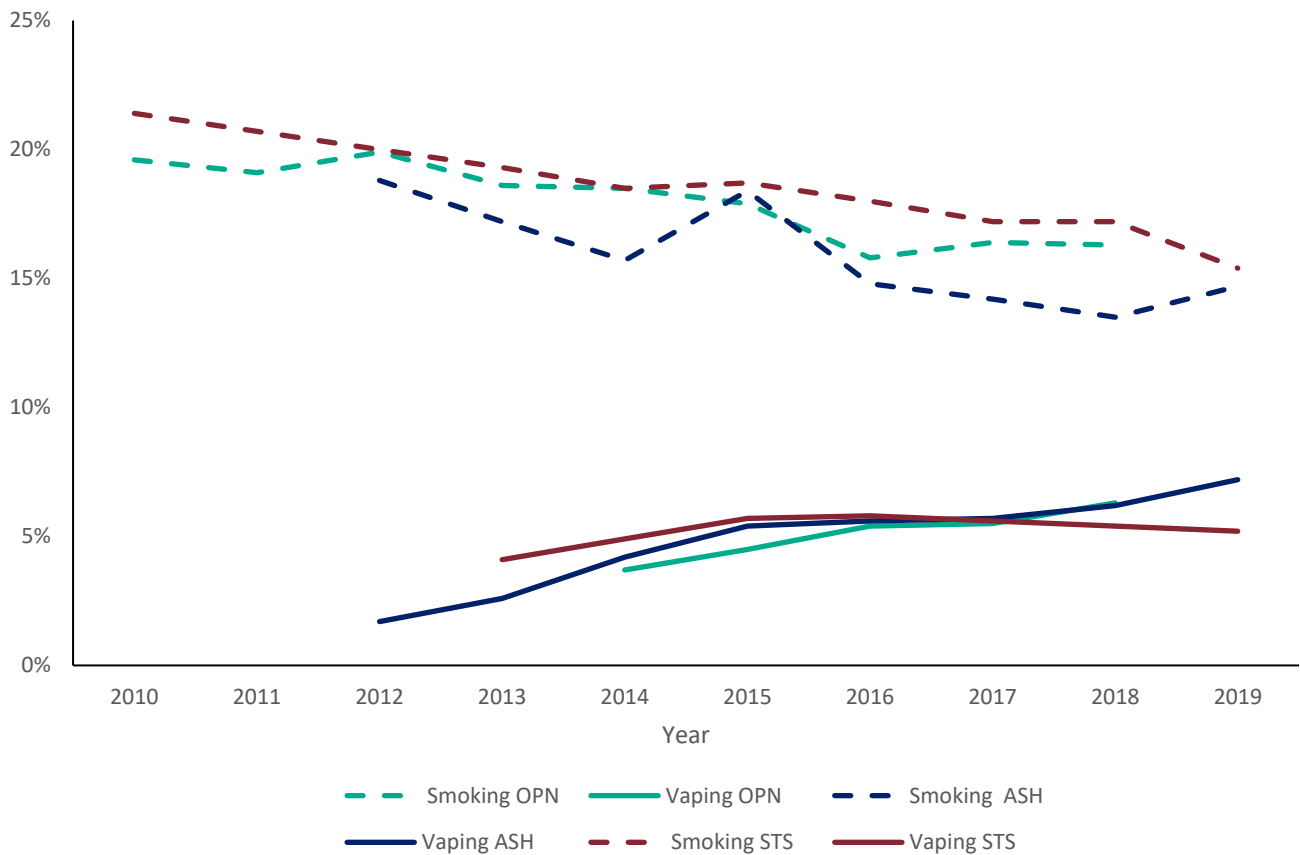**OPN:** Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays". Current vaping was people who answered "yes, I currently use one" to a question about whether they had ever vaped.
STS: Current cigarette smokers were those saying that they smoked ever day or that they smoked but less than daily. Current vaping was 'current vaping for any reason'.

Vaping and smoking by demographic characteristics

Estimates of vaping prevalence was lower than smoking prevalence across all gender, age and regional variations (Table 9). Estimates of vaping prevalence for women are between 4.2% and 7.0% and are between 6.2% and 7.9% for men. The highest prevalence of vaping in England was in the West Midlands (8.3%) and the lowest was in the South-West (6.1%). There appeared to be a general pattern of higher vaping prevalence among 25- to 54-year-olds across surveys, with lower vaping prevalence among those under 25 and 55 and over. The lower smoking figures in over-55s are potentially attributable to increased mortality among older smokers.

Table 9: Current vaping and smoking prevalence (%) by gender, age and region among adults from 3 national surveys; England, 2018 and 2019 (weighted data)

		OPN 2018 Age 16+		ASH-A 2019 Age 18+		STS 2019 Age 16+	
		Vaping	Smoking	Vaping	Smoking	Vaping	Smoking
Gender	Men	7.9	16.7	7.4	14.8	6.2	16.6
	Women	4.6	15.8	7.0	14.3	4.2	14.2
Age	Under 25	5.2	**24.5**	**4.1**	15.3	4.9	17.4
	25 to 34	7.0	20.5	8.4	**18.3**	**6.9**	**22.6**
	35 to 44	**8.1** (35-49)	17.6 (35-49)	9.1	16.3	6.4	16.5
	45 to 54	7.3 (50-59)	15.3 (50-59)	**9.6**	17.3	6.3	16.5
	55+	**4.1** (60+)	**9.5** (60+)	5.5	**10.6**	5.7	14.3
	65+					**2.0**	**7.8**

		APS Smoking	ASH-A Vaping	ASH-A Smoking			
Region	North East	16.0	7.9	14.4	-		-
	North West	14.7	7.4	15.4	-		-
	Yorkshire and Humber	**16.7**	7.8	13.0	-		-
	East Midlands	15.8	7.7	**12.6**	-		-
	West Midlands	14.5	**8.3**	15.3	-		-
	East of England	14.0	6.3	13.3	-		-
	London	13.9	7.1	**18.4**	-		-
	South East	**12.9**	6.8	14.0	-		-
	South West	13.9	**6.1**	14.0	-		-

Notes: Bold text indicates highest and lowest data point in each age / region
Unweighted bases = APS = 152,816; OPN = 6,619; ASH-A = 10,338; STS = 18,862.
ASH-A: Current smoking included people who smoked daily as well as those who smoked, but not daily. Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.
OPN: Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays". Current vaping was people who answered "yes, I currently use one" to a question about whether they had ever vaped.
STS: Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily. Current vaping was "Current use for any reason".
APS: Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays".

Vaping by smoking status

Between 14.4% and 19.9% of smokers vape, figures that represent little change from previous reports [4, 5]. Vaping prevalence among former smokers was between 11% and 13%. All surveys reported very low levels of vaping among never smokers with all estimates below 1% (Table 10).

Vaping among never smokers remains low across all age groups (Figure 15). Vaping prevalence among long-term (>1year) former smokers seemed to decline by age. By contrast, vaping prevalence was higher among short-term (<1year) former smokers aged 45 to 63 than among younger short-term former smokers. This suggests that a larger proportion of older people who recently quit smoking use vaping products compared to younger people who have recently quit smoking.

The ASH-A survey provides data on vaping frequency (Figure 16) and shows that the highest levels of daily vaping were among former smokers. Among the small proportion of never smokers who had vaped, most vaped less than once a month or had tried vaping once or twice, underscoring the importance of reporting vaping frequency alongside vaping prevalence. There were few differences in the vaping frequency of people who smoke daily and people who smoke less than daily.

Table 10: Current vaping prevalence (%) by smoking status among adults in 3 national surveys; England, 2018 and 2019 (weighted data)

	OPN 2018 Age 16+	ASH-A 2019 Age 18+	STS 2019 Age 16+
Smoking status			
Never smokers	0.9	0.9	0.5
Current smokers	14.4	19.9	18.2
Former smokers	12.9	11.6	11.6

Notes: Unweighted bases: OPN = 6,619; ASH-A = 10,338; STS = 18,862
ASH-A: Current smoking included people who smoked daily as well as those who smoked, but not daily.
OPN: Current smoking was defined as people who had tried cigarettes and that said they still smoked "nowadays".
STS: Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily. STS data available from January to November 2019.

Figure 15: Vaping prevalence by smoking status and by age; England, 2019 (STS, weighted data)

■ Vaping among never smokers   ■ Vaping among long-term (>1year) former smokers

■ Vaping among short-term (<1year) former smokers   ■ Vaping among current smokers
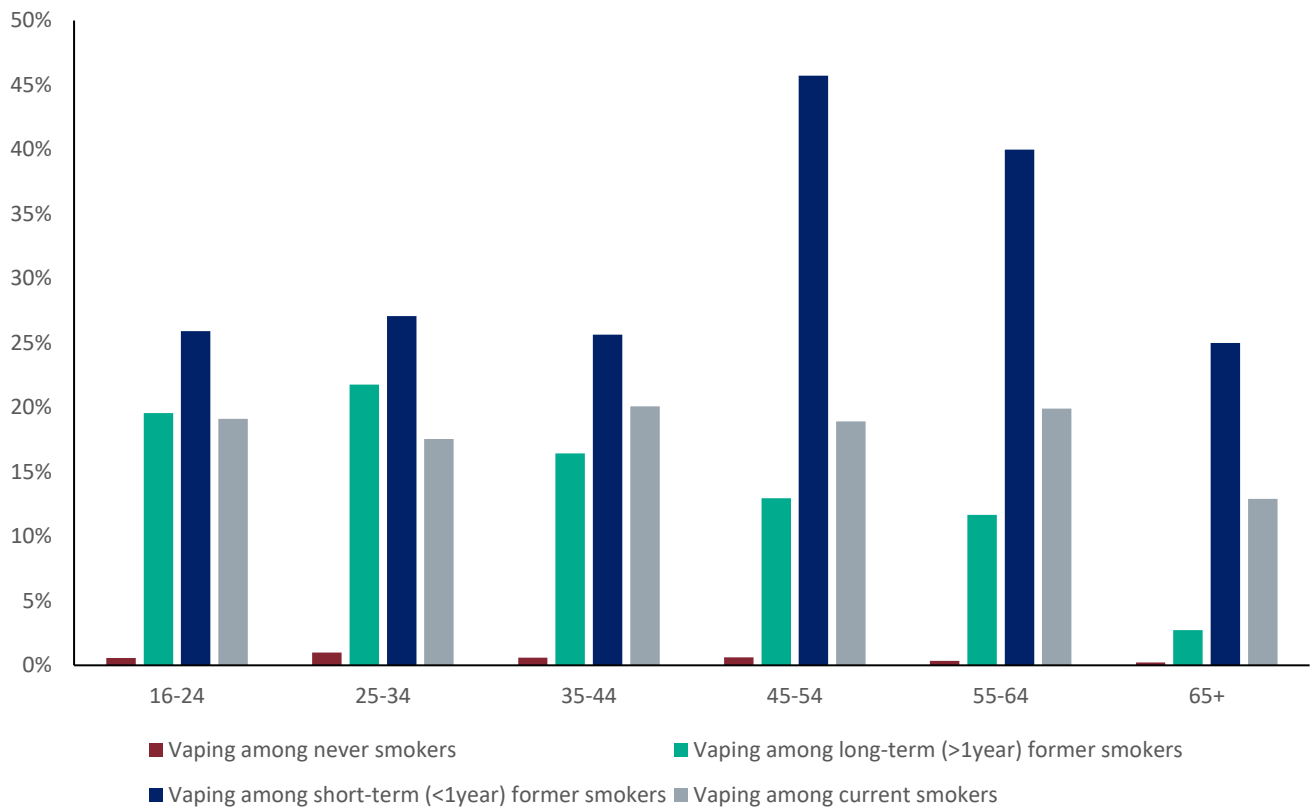
Notes: Unweighted bases by age group: 16-24 = 2,812; 25-34 = 2,716; 35-44 = 2,715; 45-54 = 2,652; 55-64 = 2,876; 65+ = 5,088. Vaping was defined as current vaping for any reason.

Figure 16: Vaping frequency by smoking status among adults who have ever tried vaping products; England, 2019 (ASH-A, weighted data)
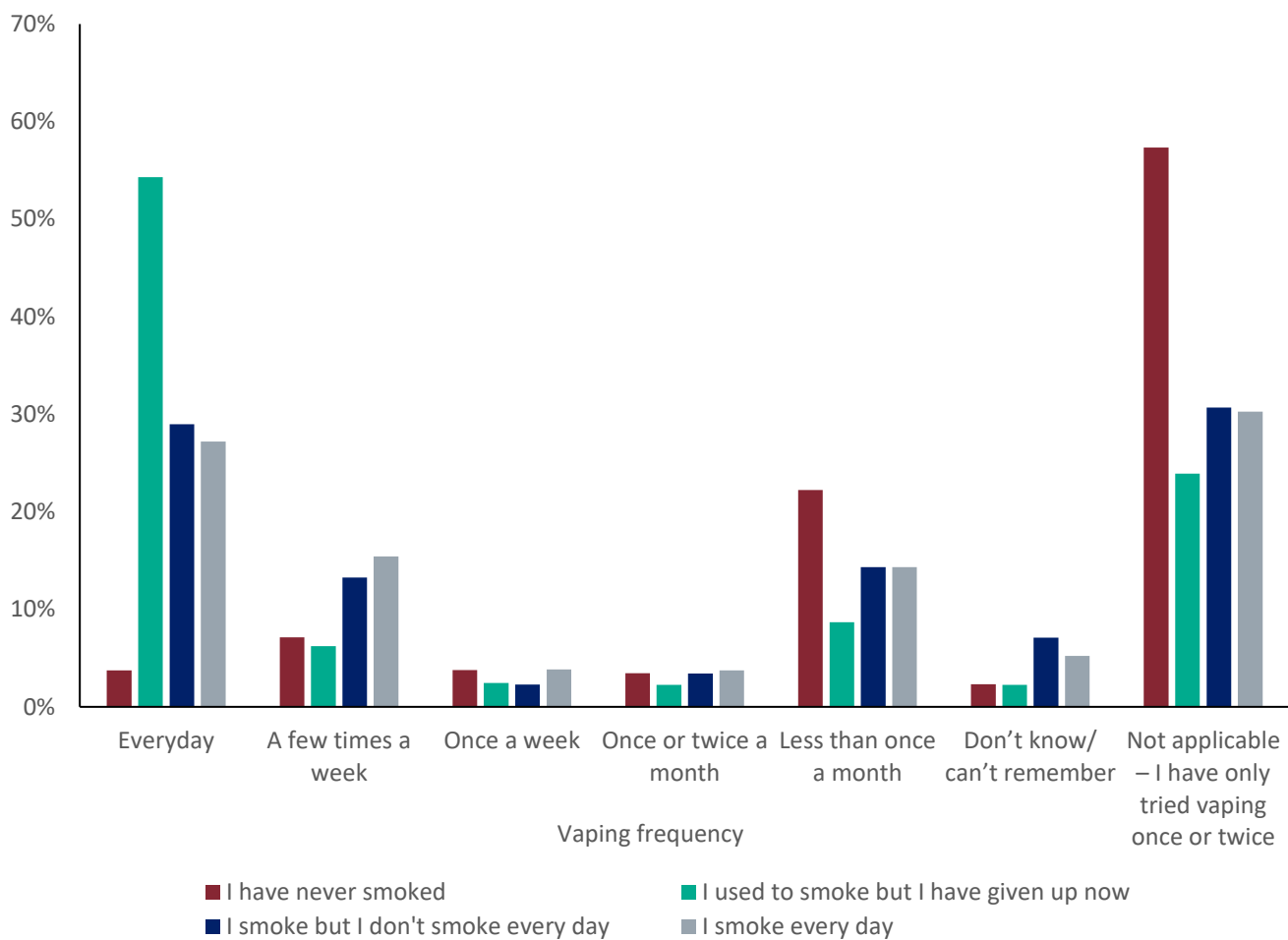
Notes: Unweighted base = 1,931

STS data suggest that the prevalence of current vaping among current and recent former smokers (people who quit smoking within the last year) has fluctuated between 16% and 24% since 2013 (Figure 17). The prevalence of daily vaping is naturally lower than the prevalence of any vaping and ranged between 8% and 16% over the same period. The figure below also illustrates that use of JUUL and heated tobacco products remains below 1.5% for smokers and recent former smokers; although it is important to note that JUUL has only been available in the UK since July 2018. In the past 12 months of the STS survey just 24 participants out of over 20,000 said they used heated tobacco products which have been available in the UK since late 2016. Similarly, in the ASH-A survey just 0.6% said they used heated tobacco products; and of those who had used heated tobacco products, just 6% used them daily.

Figure 17: Vaping prevalence among smokers and recent (<1 year) former smokers; England, 2011 to 2019 (STS, weighted data)

Notes: Unweighted bases: 2011 = 5,298; 2012 = 3,422; 2013 = 4,011; 2014 = 4,252; 2015= 4,201; 2016 = 3,967; 2017 = 3,684; 2018 = 3,784; 2019 (to November) = 3,115.
Definitions: JUUL and heated tobacco product use was all reported use. Current vaping was current vaping for any reason. Smokers were those saying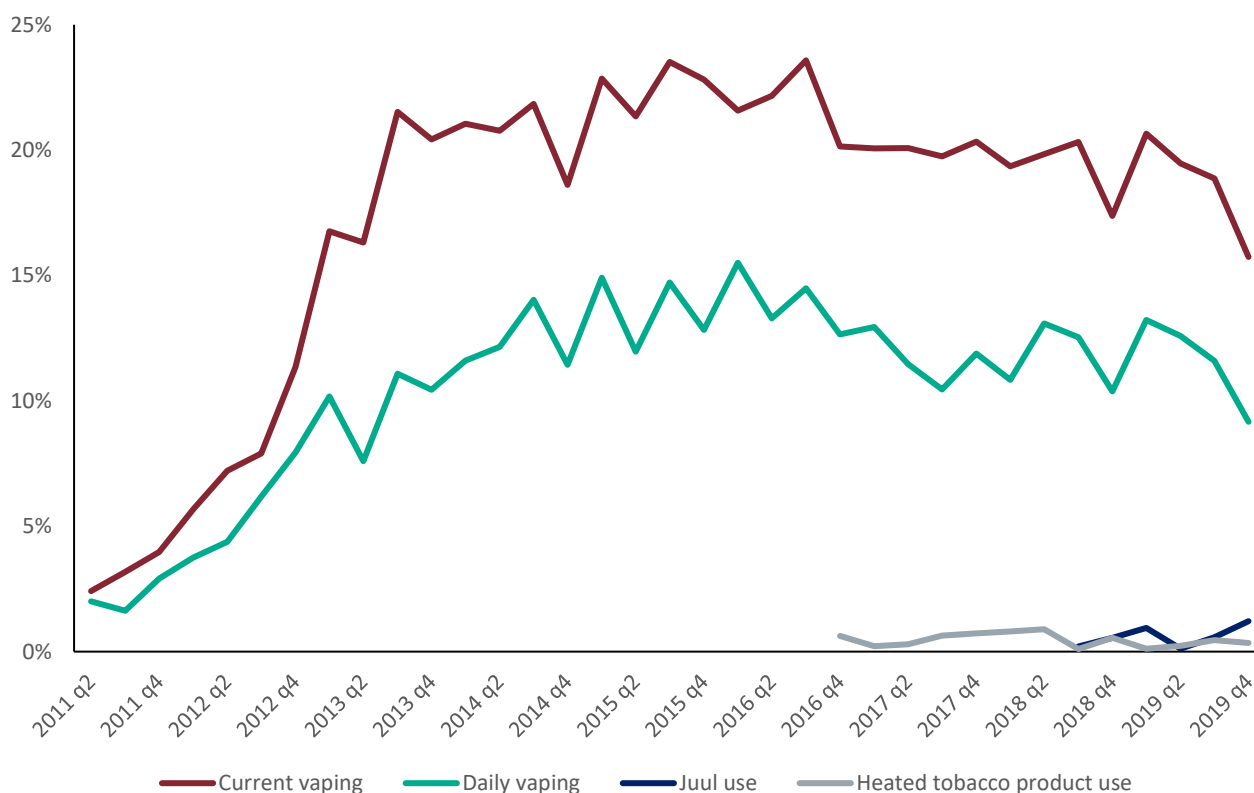 that they smoked daily or that they smoked less than daily. Recent former smokers were those who had quit smoking in the past year.

Figure 18 shows that the prevalence of vaping among long-term former smokers (those having quit smoking for longer than one year) has steadily increased over time, from 1.8% in 2013 to 11.6% in the second quarter of 2019. The STS data presented here suggest a continued increase in vaping among former smokers (Figure 18). These data also illustrate that use of Nicotine Replacement Therapy (NRT) by long-term former smokers remains low, declining slightly from 3.2% in 2013 to 2.7% in 2019. The proportion of people who have never smoked who use either NRT or vaping products remains consistently under 1%, the most recent data estimating this at 0.3% for vaping and 0.5% for NRT.

**Figure 18: Use of vaping products and nicotine replacement therapy by never smokers and long-term (>1 year) former smokers; England, 2014 to 2019 (STS, weighted data)**
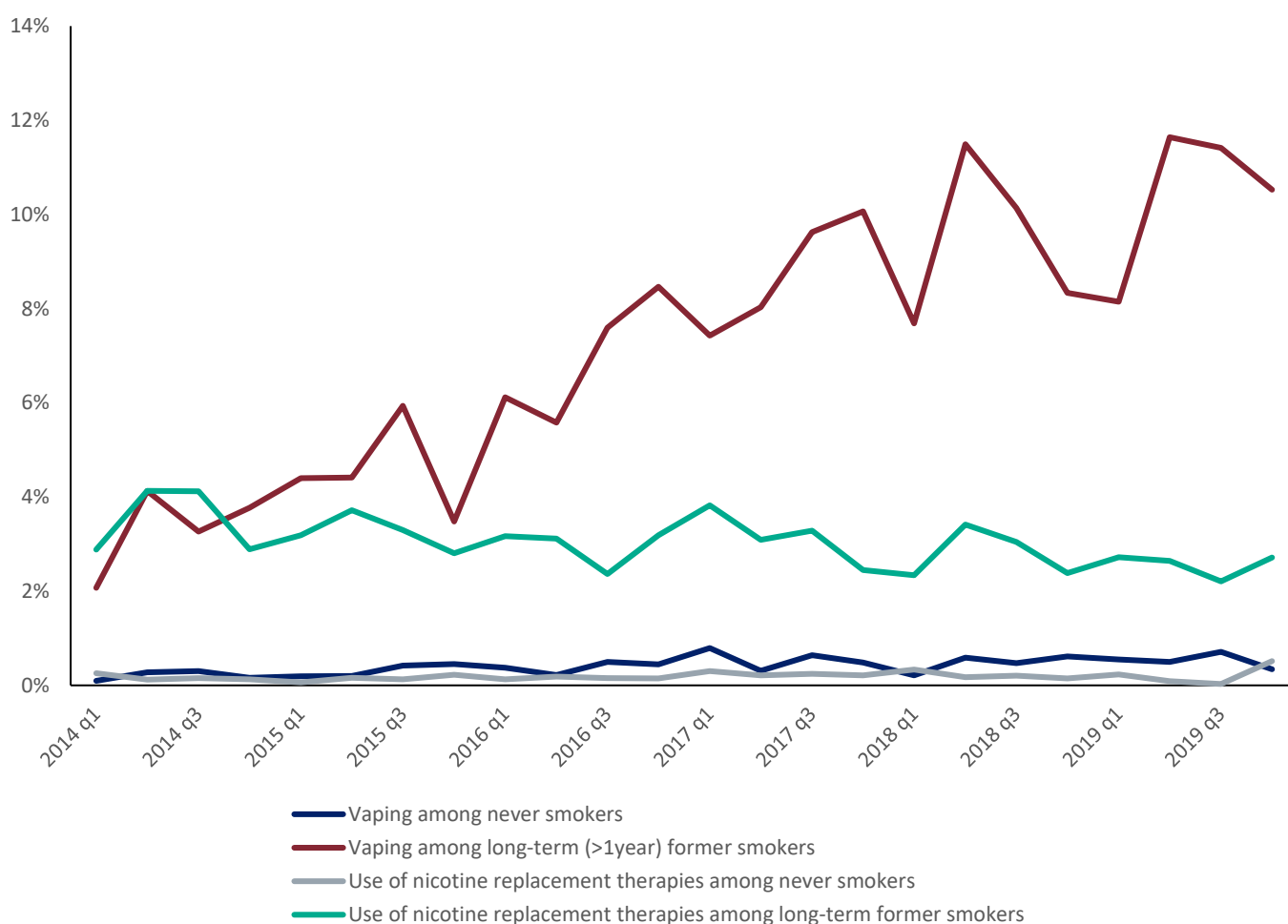
Notes: Unweighted bases: 2014 = 15,915; 2015 = 15,825; 2016 = 16,466; 2017 = 16,696; 2018 = 16,899; 2019 (to November) = 15,742
Use of nicotine replacement therapy was people who were currently using NRT. Use of vaping devices was current vaping for any reason.

Figure 19 presents ASH-A data on the changes in vaping prevalence among smokers, former smokers and never smokers over time in England. Current vaping among current smokers (those who smoke daily as well as those who smoke less than daily) increased from 6.6% to 17.6% between 2012 and 2014 and then rose slowly to 19.9% between 2014 and 2019. The proportion of current smokers who had not tried vaping products remained at 37% between 2018 and 2019. The proportion of never smokers who currently vape has remained at very low levels, with marginal increases in trial among this group. As with the STS data presented above (Figure 18), both trial and current vaping have slowly increased among former smokers over the 7-year period. The proportion of former smokers who had ever tried vaping increased from 3.9% in 2012 to 25.3% in 2019 with current use rising from 1.1% in 2012 to 11.6% in 2019.

Figure 19: Ever tried and current use of vaping products by smoking status among adults; England, 2010 and 2012 to 2019 (ASH-A, weighted data)
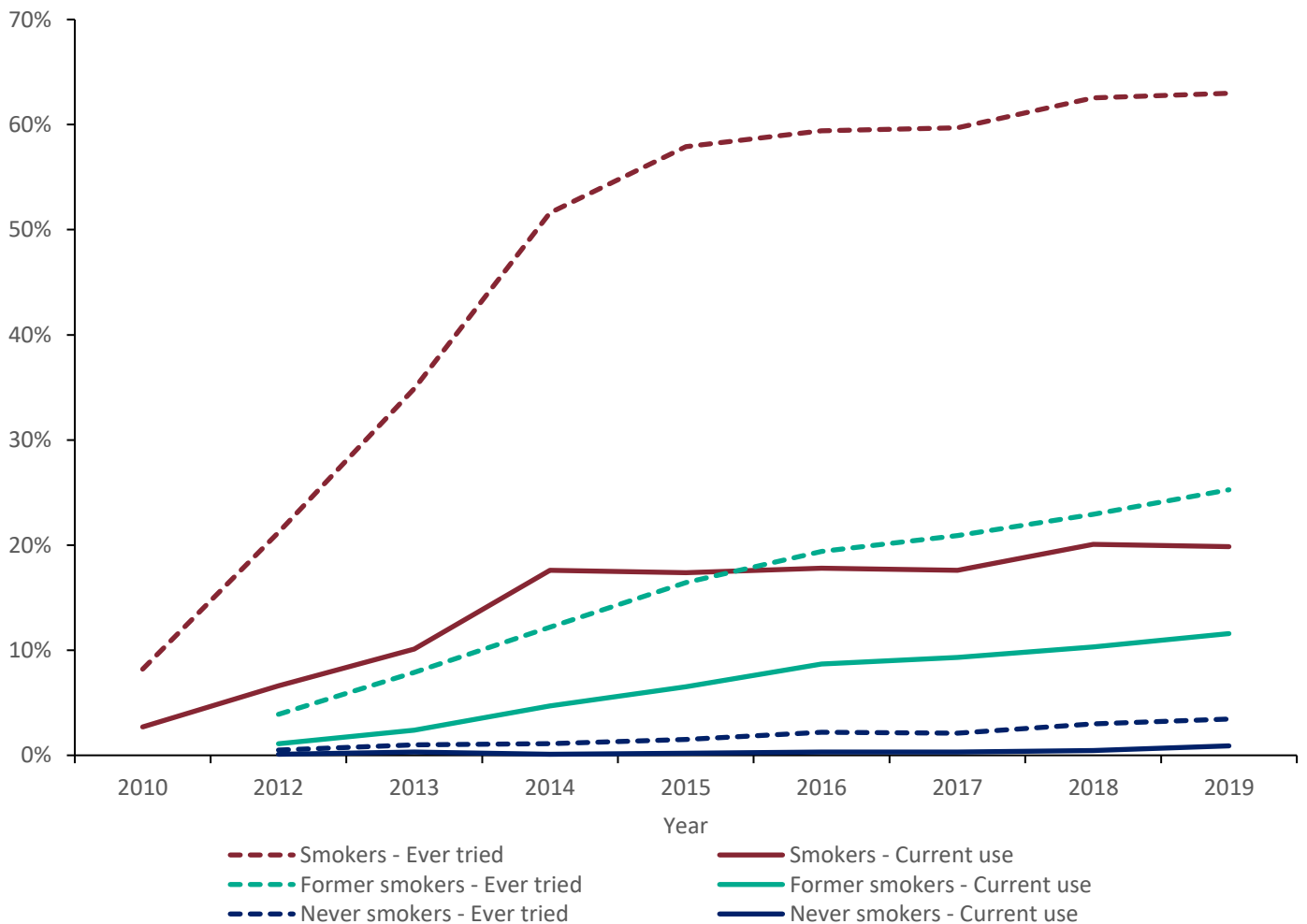
Notes: Unweighted bases: 2012 = 9,999; 2013 = 10,023; 2014 = 10,112; 2015 = 10,017; 2016 = 10,058; 2017 = 10,488; 2018 = 10,578; 2019 = 10,338.
"Smokers" includes people who smoked daily as well as those who smoked less than daily; "former smokers" are those who used to smoke but who had given up. "Current use" of vaping products refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

The ASH-A data indicate that the prevalence of smoking among vapers continues to decline (Figure 20), indicating that the proportion of people who continue to use both vaping and tobacco products (dual use) is going down. This is important to monitor because dual users are still exposed to the high levels of harm associated with smoking. The proportion of vapers who are former smokers has increased, suggesting that increasing numbers of vapers have quit smoking although the surveys do not distinguish between those who quit using vaping and those who took up vaping after quitting smoking. The proportion of vapers who have never smoked has risen to 6.6%.

The wording used to establish the smoking and vaping status of participants differed between the ASH-A and STS surveys. Therefore, the proportion of vapers who were current, former and never smokers also differed. Despite this, the direction of changes over time reported by both surveys were similar. In the STS survey the proportion of vapers who were current smokers was 55.7% (n=541) in 2019, compared with 59.1% (n=652) in 2018, the proportion of vapers who were former smokers was 37.3% (n=340) in 2019 compared with 35.2% (n=367) in 2018. The STS data also show that the proportion of vapers who had never smoked was 7.1% (n=70) in 2019 compared with 5.7% (n=59) in 2018. It is important to note that an increase in the proportion of vapers who are never smokers also reflects an increasing proportion of never smokers in the general population; furthermore, there were relatively small numbers of people in both surveys who were both current vapers and never smokers and so changes to this figure must be interpreted with caution. More research is needed to understand whether vaping by never smokers is likely to increase population use of nicotine or prevent people from initiating smoking.

Figure 20: Smoking status of current vapers; England, 2014 to 2018 (ASH-A, weighted data)
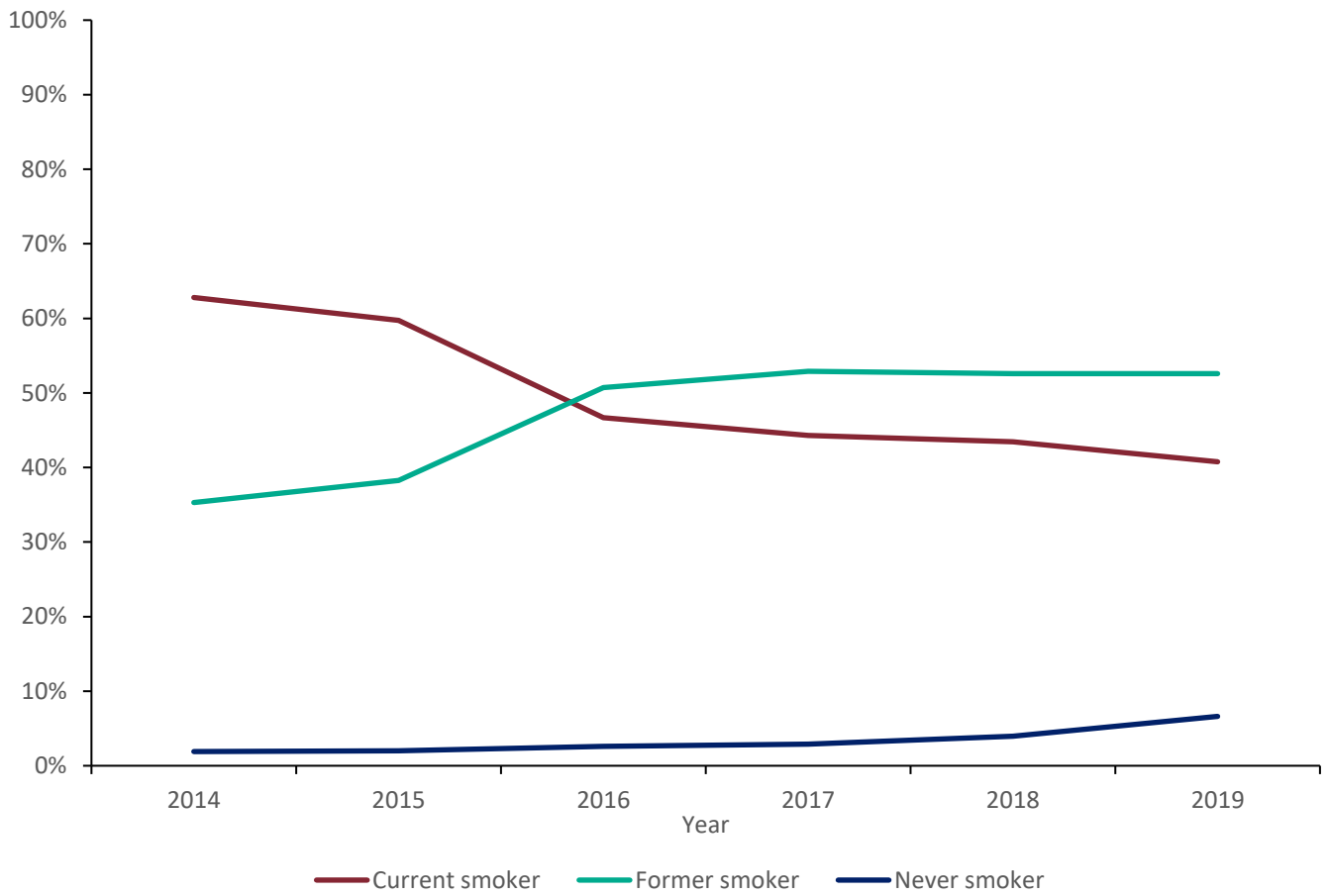
Notes: Unweighted bases 2014 = 407; 2015 = 508; 2016 = 545; 2017 = 543; 2018 = 620; 2019 = 705. Current smoking included people who smoked daily as well as those who smoked, but not daily. Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

Vaping by socio-economic status

STS data allow for analysis of vaping and smoking by socio-economic status using the National Readership Survey categories (see Table 11) as illustrated in Figures 21, 22 and 23. Figure 21 highlights the differences in smoking prevalence across groups; in 2019, smoking in grade AB was estimated at 7.4% compared to 26.7% in grade E. Smoking prevalence across all socio-economic groups has declined in the past 10 years.

Table 11: Social grade classifications derived from the National Readership Survey

Social Grade	Description
A	High managerial, administrative or professional
B	Intermediate managerial, administrative or professional
C1	Supervisory, clerical and junior managerial, administrative or professional
C2	Skilled manual workers
D	Semi and unskilled manual workers
E	State pensioners, casual or lowest grade workers, unemployed with state benefits only

The figures for vaping (Figure 22) are more complex. They show an increase in vaping prevalence across all groups between 2010 and 2015, followed by stable or fluctuating levels of vaping prevalence since then. Vaping in 2019 ranged from 3.7% in grade AB to 7.1% in grade C1.

It is notable that vaping prevalence among groups C2 to E (as displayed in Figure 22) are broadly similar, yet the levels of smoking prevalence (Figure 21) have remained distinct and with no overlap.

Figure 23 illustrates vaping prevalence among past year smokers across the different socio-economic groups and, notably, gives a different perspective to Figure 22. The figures show that, although smoking and vaping prevalence are lower among socio-economic groups AB and C1, the prevalence of vaping among smokers and recent former smokers is higher in socio-economic groups AB and C1 compared to other groups. Please note that a more detailed analysis of vaping and smoking by SES was completed in our 2019 PHE report on vaping [5] and by Koch and colleagues [83].

Figure 21: Smoking prevalence by socio-economic status among all adults; England, 2009 to 2019 (STS, weighted data)

Notes: Unweighted bases: 2009 = 21,136; 2010 = 24,792; 2011 = 21,878; 2012 = 21,330; 2013 = 22,167; 2014 = 20,167; 2015 = 20,026; 2016 = 20,433; 2017 = 20,380; 2018 = 20,683; 2019 (to November) = 18,857. Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily. Social grade definitions [84]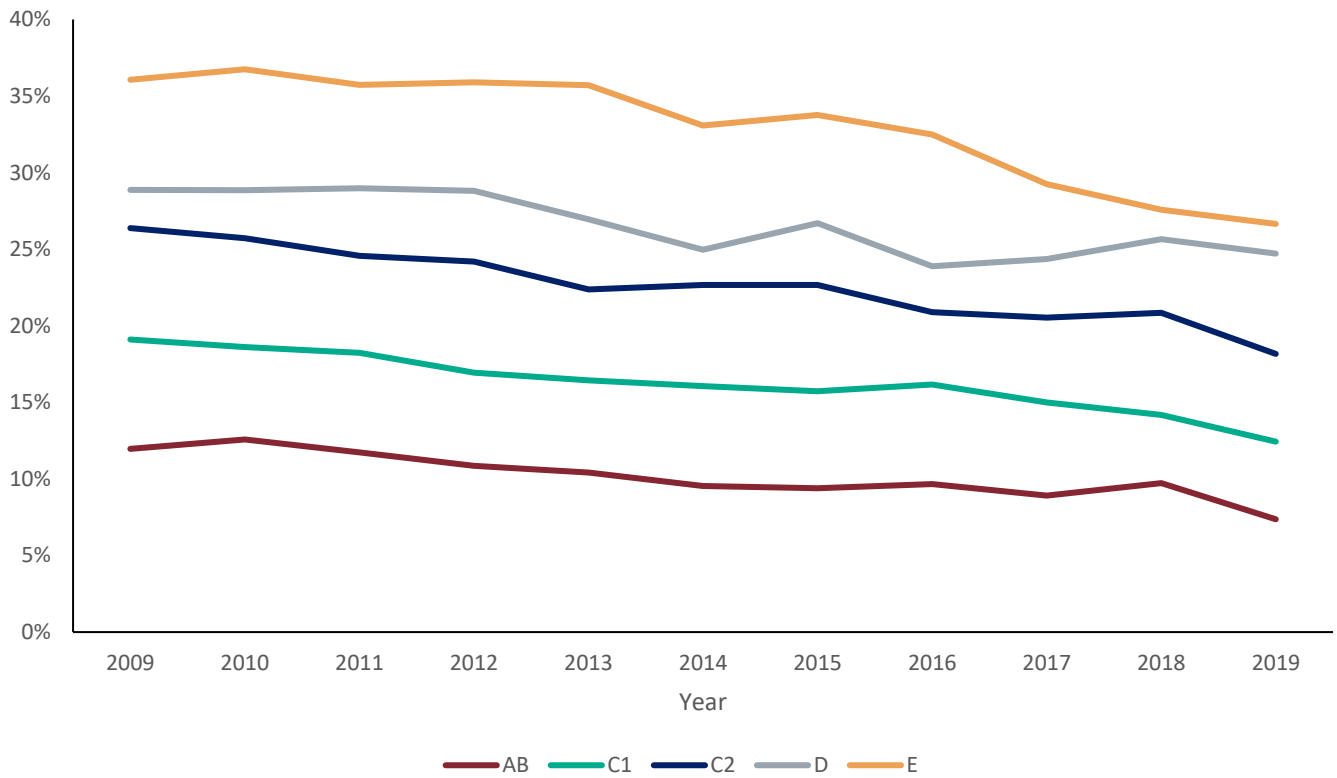: A = High managerial, administrative or professional; B = Intermediate managerial, administrative or professional; C1 = Supervisory, clerical and junior managerial, administrative or professional; C2 = Skilled manual workers; D = Semi and unskilled manual workers; E = State pensioners, casual or lowest grade workers, unemployed with state benefits only.

Figure 22: Vaping prevalence by socio-economic status among all adults; England, 2009 to 2019 (STS, weighted data)
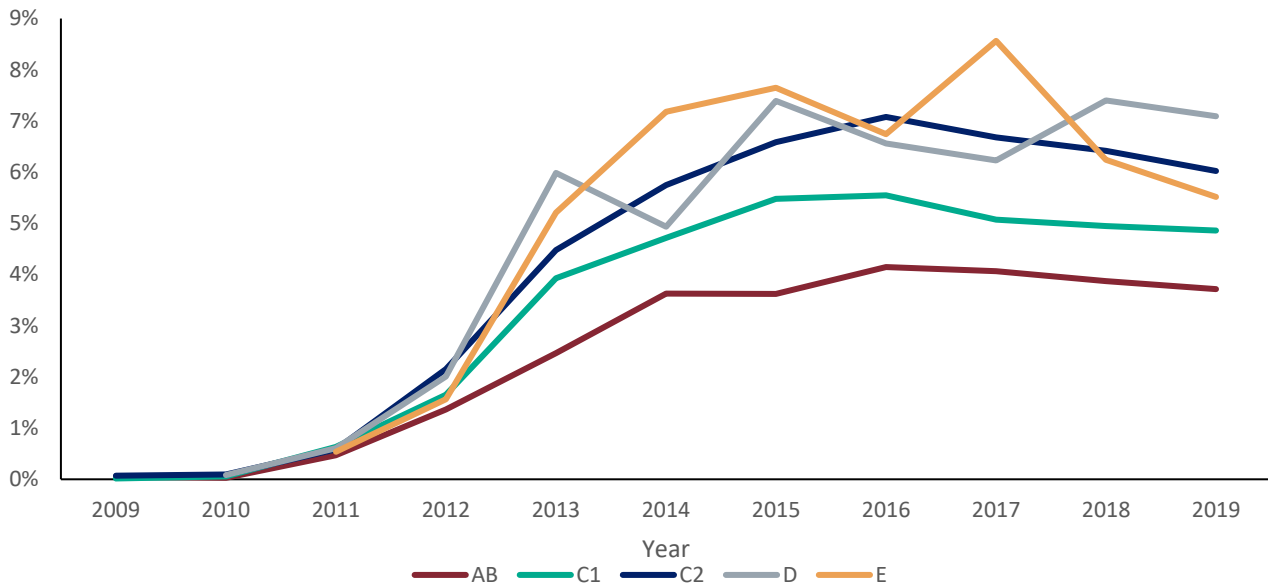
Notes: Unweighted bases: 2009 = 21,142; 2010 = 24,819; 2011 = 21,894; 2012 = 14,262; 2013 = 18,751; 2014 = 20,192; 2015 = 20,034; 2016 = 20,436; 2017 = 20,395; 2018 = 20,702; 2019 (to November) = 18,862. Current vaping was 'Current use for any reason'.
Social grade definition [84]: A = High managerial, administrative
or professional; B = Intermediate managerial, administrative or professional; C1 = Supervisory, clerical and junior managerial, administrative or professional; C2 = Skilled manual workers; D = Semi and unskilled manual workers; E = State pensioners, casual or lowest grade workers, unemployed with state benefits only.

Figure 23: Vaping prevalence by socio-economic status among past year smokers; England, 2009 to 2019 (STS, weighted data)
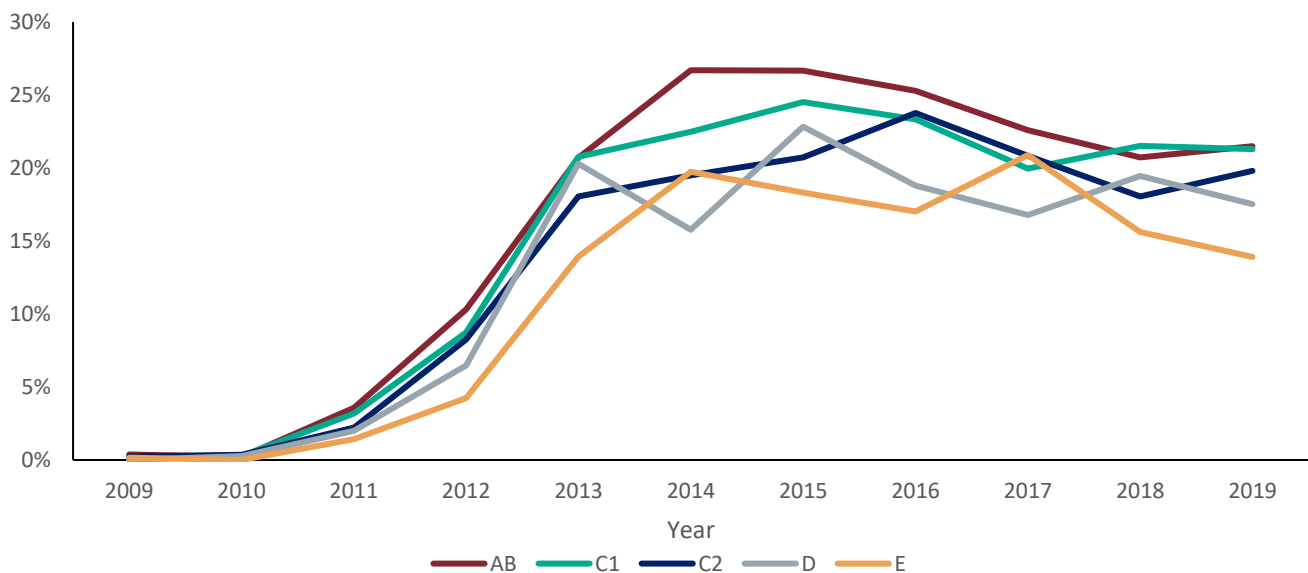
Notes: Unweighted bases: 2009 = 5,169; 2010 = 6,099; 2011 = 5,298; 2012 = 3,422; 2013 = 4,011; 2014 = 4,252; 2015 = 4,201; 2016 = 3,967; 2017 = 3,684; 2018 = 3,784; 2019 (to November) = 3,115
Current vaping was 'Current use for any reason'.
Social grade definition [84]: A = High managerial, administrative or professional; B = Intermediate managerial, administrative or professional; C1 = Supervisory, clerical and junior managerial, administrative or professional; C2 = Skilled manual workers; D = Semi and unskilled manual workers; E = State pensioners, casual or lowest grade workers, unemployed with state benefits only.

Duration of use

The proportion of past and current vapers who have vaped for more than 3 years rose from 14.5% in 2018 to 17.6% in 2019 (ASH-A, Table 12) with few changes in other measures of vaping duration.

Table 12: Duration of vaping among past and current vapers; England, 2018 and 2019 (ASH-A, weighted data)

Duration of vaping	2018 (%)	2019 (%)
1 month or less	16.2	17.5
More than 1 month, up to 3 months	15.4	15.7
More than 3 months, up to 6 months	12.2	9.7
More than 6 months, up to 1 year	13.4	11.0
More than 1 year, up to 2 years	15.2	13.5
More than 2 years, up to 3 years	11.0	11.6
More than 3 years	14.5	17.6
Don't know	2.1	3.4

Notes: Unweighted bases: 2018 = 1,114; 2019 = 1,257.
Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

Reasons for vaping

The 2018 OPN data provided an analysis of the reasons for vaping among current vapers, whereas the ASH-A data enabled the reasons for vaping to be analysed for all people who had tried vaping. These 2 analyses will also differ because the ASH-A survey question contained more response options than the OPN survey, was restricted to people aged 18 or over, as opposed to those aged 16 or over and used a different sampling strategy.

The main reason for vaping among survey participants was to help quit smoking, with 51.5% of OPN participants and 45.9% of ASH-A selecting smoking cessation related items (for ASH-A these were "to help stop smoking", "an aid to keep off tobacco" and "because I feel addicted to smoking") as their main reason (Figures 24 and 25). Other popular reasons for vaping included the perception that vaping was less harmful than smoking, that they enjoyed vaping and that vaping products were cheaper than tobacco (OPN). In the ASH-A survey, other popular reasons included to maintain abstinence from cigarettes, to save money and to enjoy the experience.

Figure 24: Main reasons for vaping among current vapers; England, 2018 (OPN, weighted data)

Notes: Unweighted base = 308.
Current vaping was people who answered "yes, I currently use one" to a question about whether they had ever vaped.

Figure 25: Main reasons for vaping among people who have tried vaping; England, 2019 (ASH-A, weighted data)
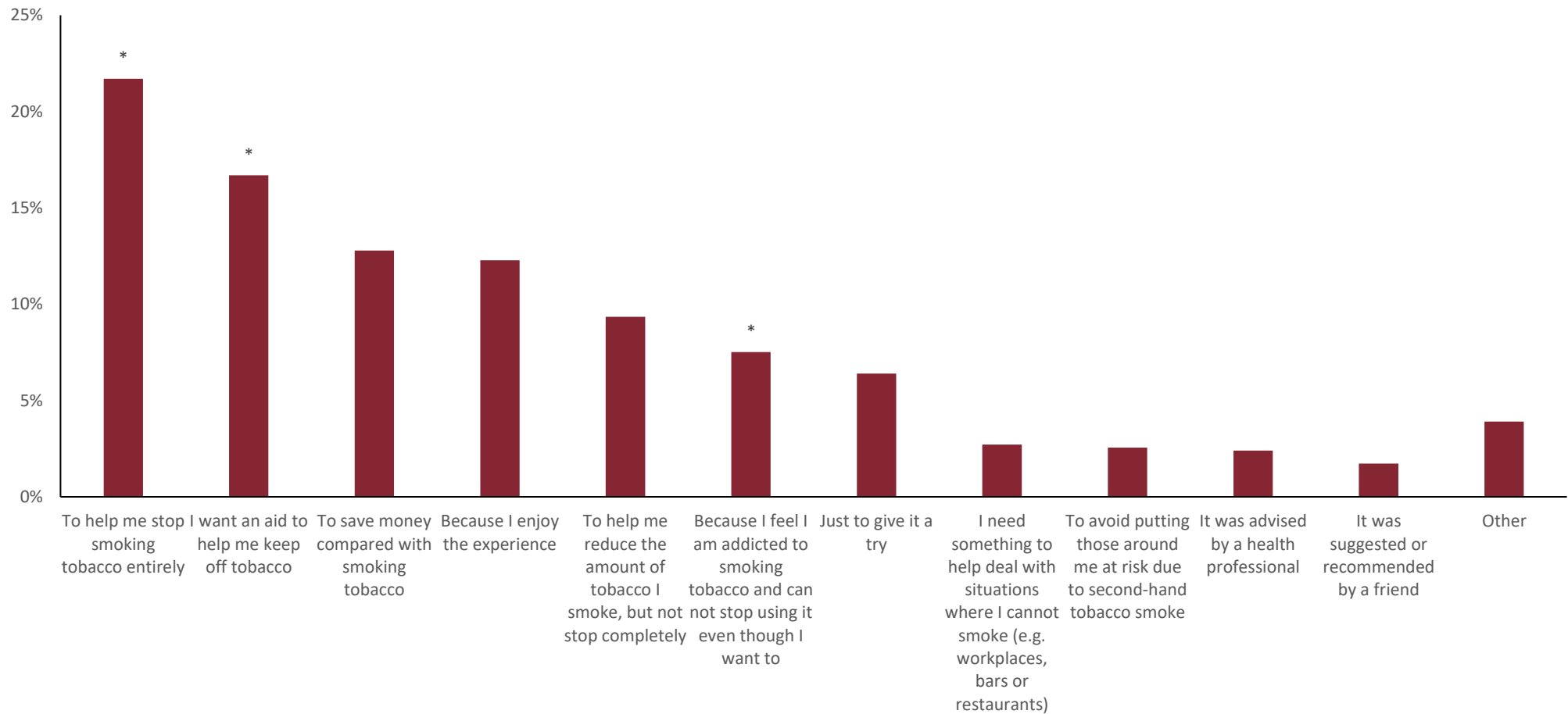
Notes: Unweighted base = 705; * indicates items related to smoking cessation

Older adults were more likely than younger adults to vape to quit smoking tobacco or to maintain abstinence. Forty-six percent of people aged between 45 and 54 cited "to stop smoking" or "to keep off tobacco" as the main reason to vape compared with 30.2% of people aged 18 to 24 (Figure 26). Younger people were more likely to vape to "give it a try" or "because [they] enjoy the experience" than older participants, with 16.6% of people aged 18 to 24 citing the experience as a main reason to vape compared to 11.0% of people aged 55 and over. People aged 25 to 34 were the most likely to have been advised to use a vaping product by a health professional with 6.6% reporting this as the main reason they vaped.

The ASH-A survey recorded the socio-economic status of participants using classifications derived from the National Readership Survey (see Table 11 for a description of these terms) [85]. It also asked participants who vaped about their reasons for doing so. Throughout the analyses presented here, classifications A and B are combined due to the small numbers in group A.

When analysed by socio-economic status (Figure 27), a greater proportion of people in group D (17.1%) than in all other groups said saving money was their main reason to vape. A greater proportion of people from group E selected "enjoyment" as a main reason to vape than people from all other socio-economic groups. Using vaping products to help continue not using tobacco products was the most popular reason among people in group AB.

Figure 26: Main reason for use by age among current vapers; England, 2019 (ASH-A, weighted data)
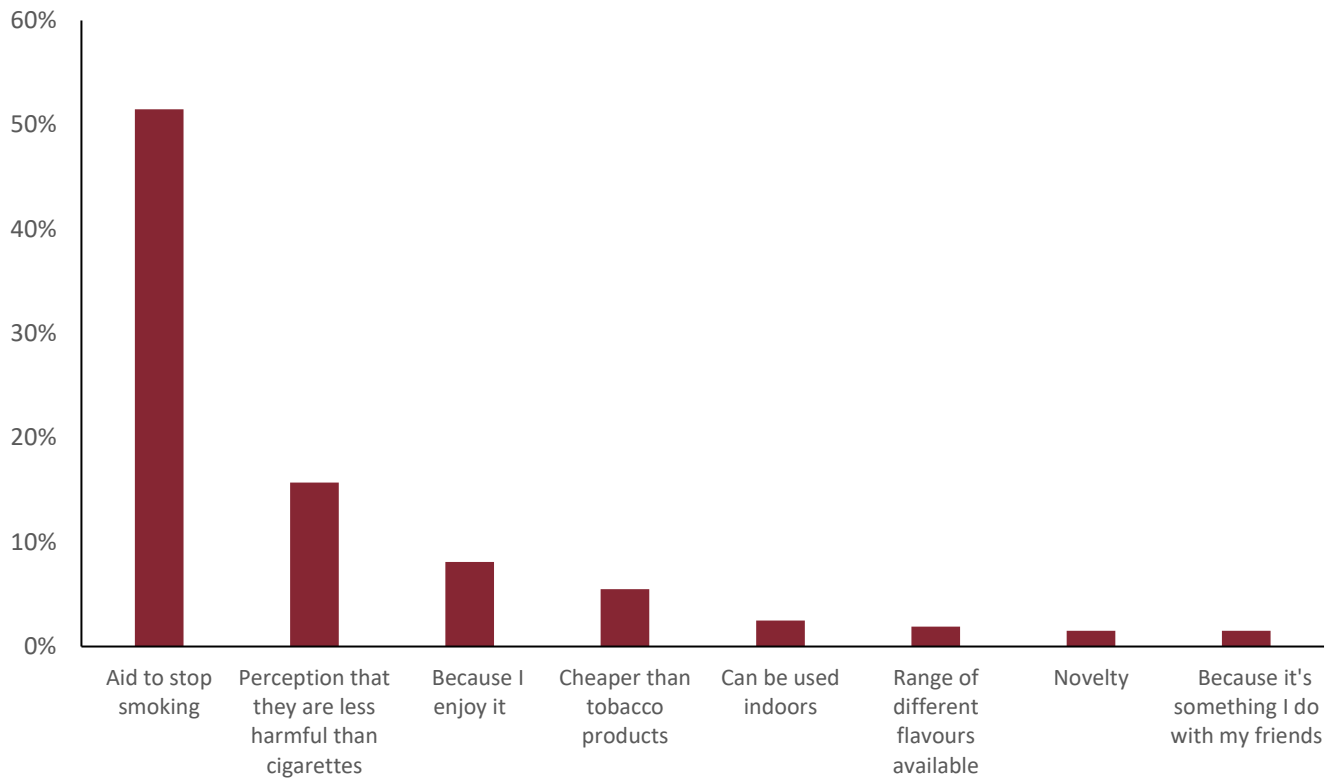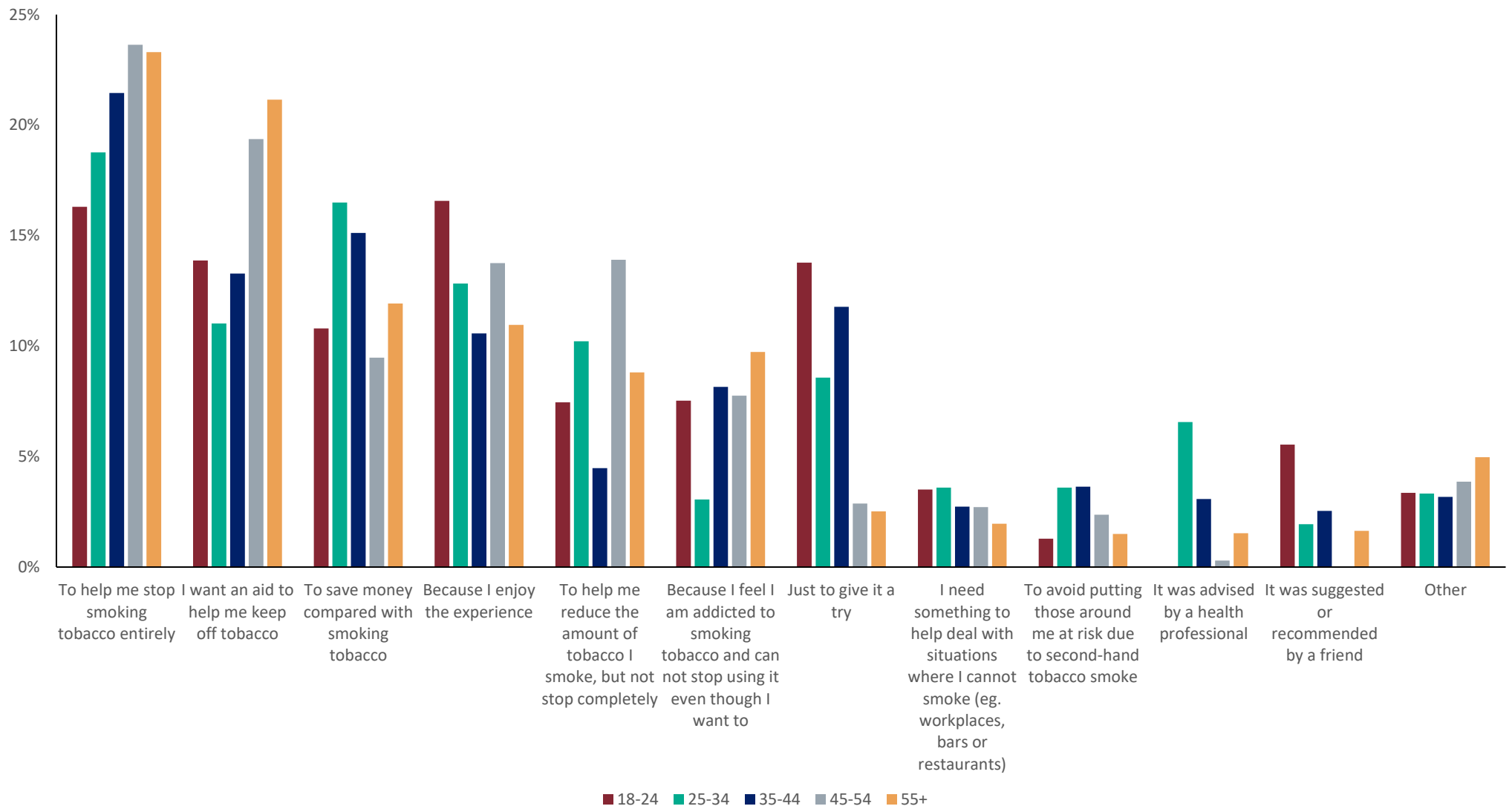

Notes: Unweighted base = 705.
Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

Figure 27: Main reason for vaping by socio-economic status among current vapers; England, 2019 (ASH-A, weighted data)
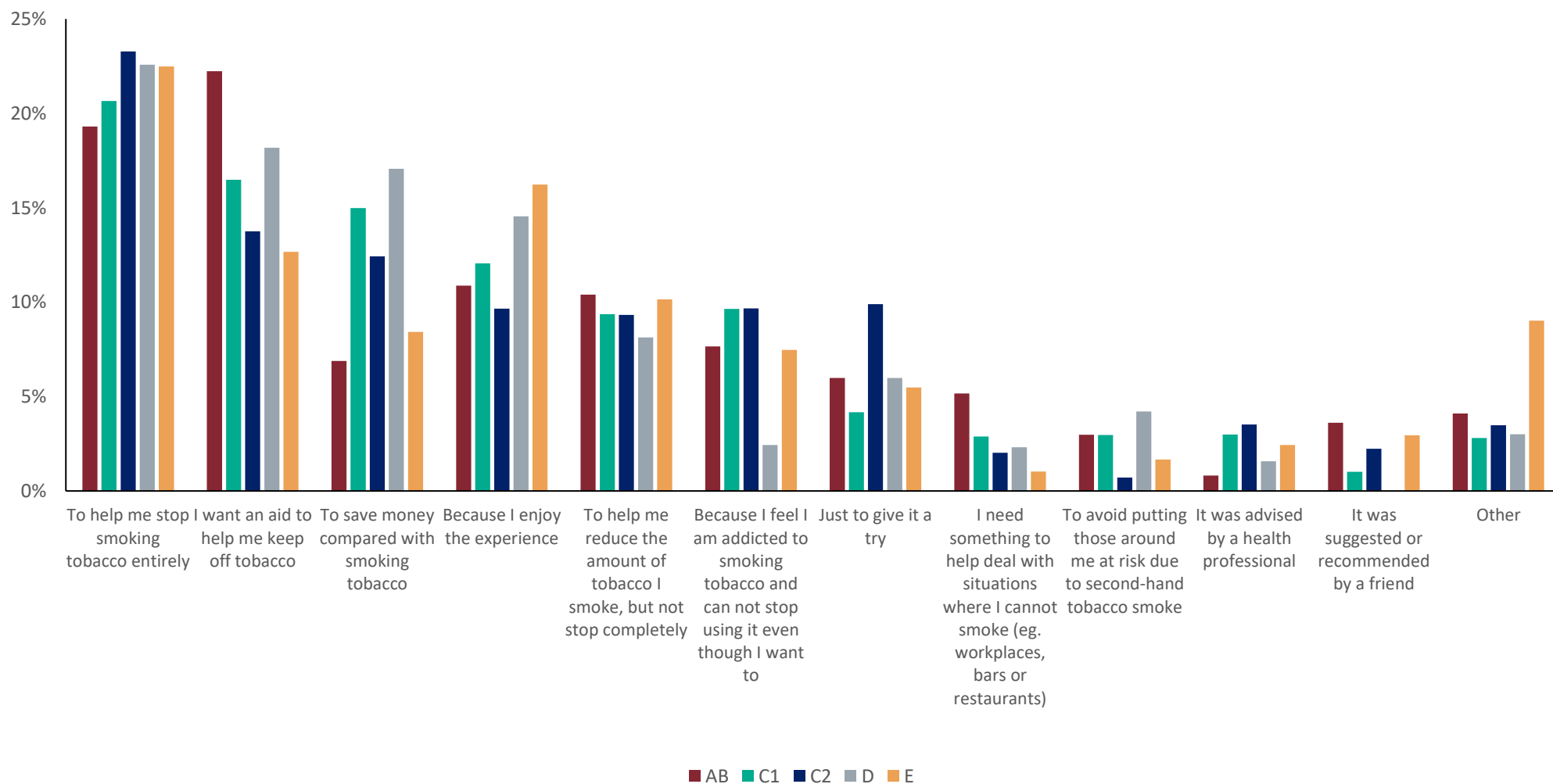
Notes: Unweighted base = 705.
Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

More substantial differences in the data were identified when the reasons to vape were analysed by smoking status (Figure 28). Never smokers were more likely to vape to "give it a try" than former or current smokers with 36.6% of never smokers selecting this as the main reason to vape. The most popular reason for vaping among current smokers was to help them reduce the amount of tobacco they smoked, this being the main reason for 20.3% of participants. When combining items, health and smoking cessation accounted for 60.1% of the reasons to vape among current smokers. The reasons relating to quitting smoking and staying stopped were most popular for former smokers and were selected by 51.6% of that group.

Figure 28: Main reason for vaping by smoking status among current vapers; England, 2019 (ASH-A, weighted data)
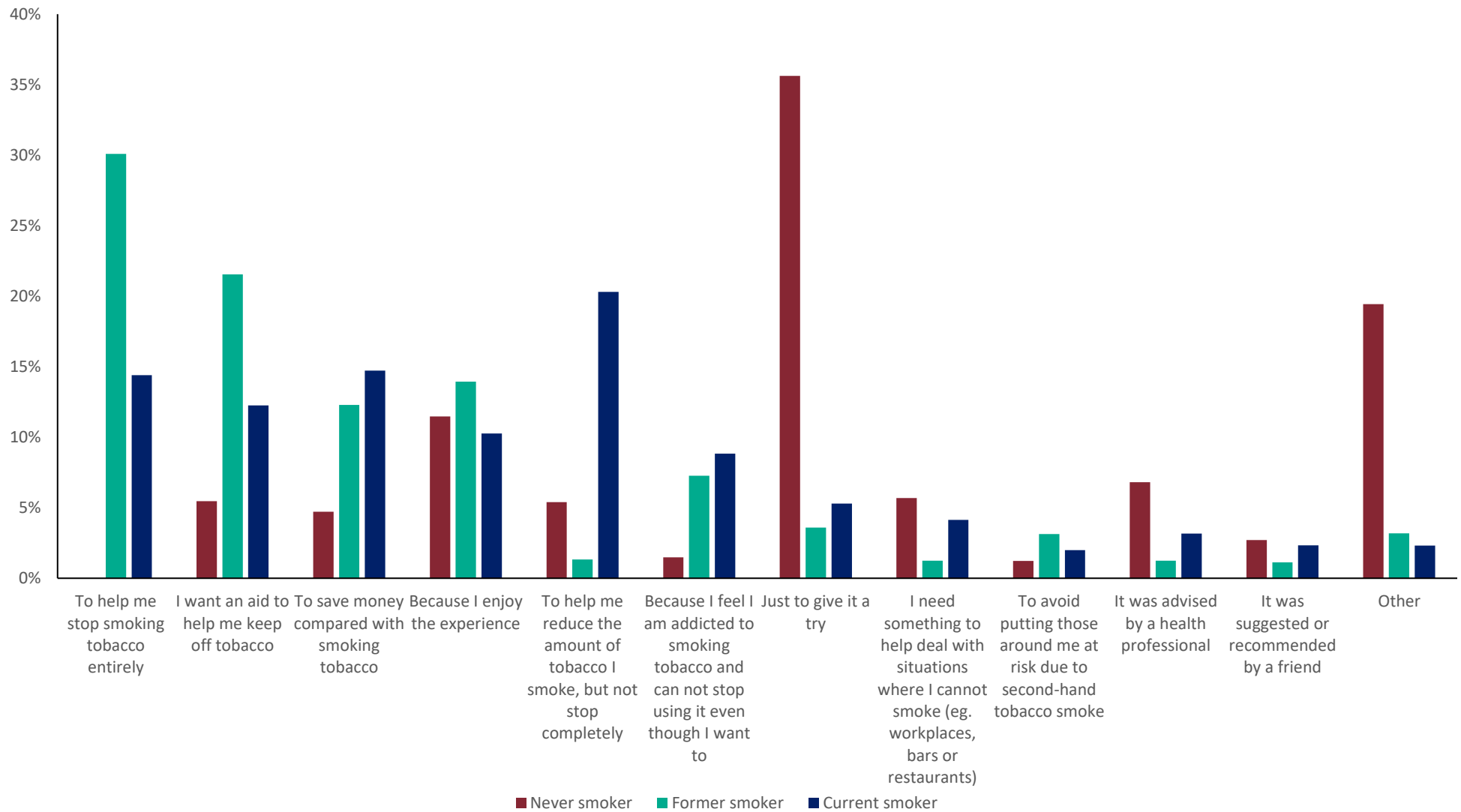
■ Never smoker   ■ Former smoker   ■ Current smoker

Notes: Unweighted base = 705.
Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

Vaping products

The most popular device type used by STS survey participants was a refillable and rechargeable device with a tank. The next most popular device types were modular systems followed by devices with replaceable cartridges, finally disposable devices were recorded as the least popular type (Figure 29). Tank-based models have been the most popular device type since 2016 and were preferred by 52.0% of vapers in 2019. Disposable vaping products remain the least popular model type with 4.9% of STS respondents preferring them in 2019.

There were small differences in vapers' preference for device type when analysed according to age, socio-economic status (Figure 30
Figure 30) and smoking status (Figure 31). STS data indicate that tank-based devices were most popular among people aged 55 to 65, people from groups AB and C2, and people who had stopped smoking in the past year. Pre-filled cartridges were most popular among people over 65 years old, people from group AB and current smokers.

Figure 29: Device type by year among current vapers; England, 2016 to 2019 (STS, weighted data)

- A disposable vaping device (non-rechargeable)
- A vaping device that uses replaceable pre-filled cartridges (rechargeable)
- A vaping device with a tank that you refill with liquids (rechargeable)
- A modular system that you refill with liquids (you use your own combination of separate devices batteries, atomisers, etc.)
- Don't know
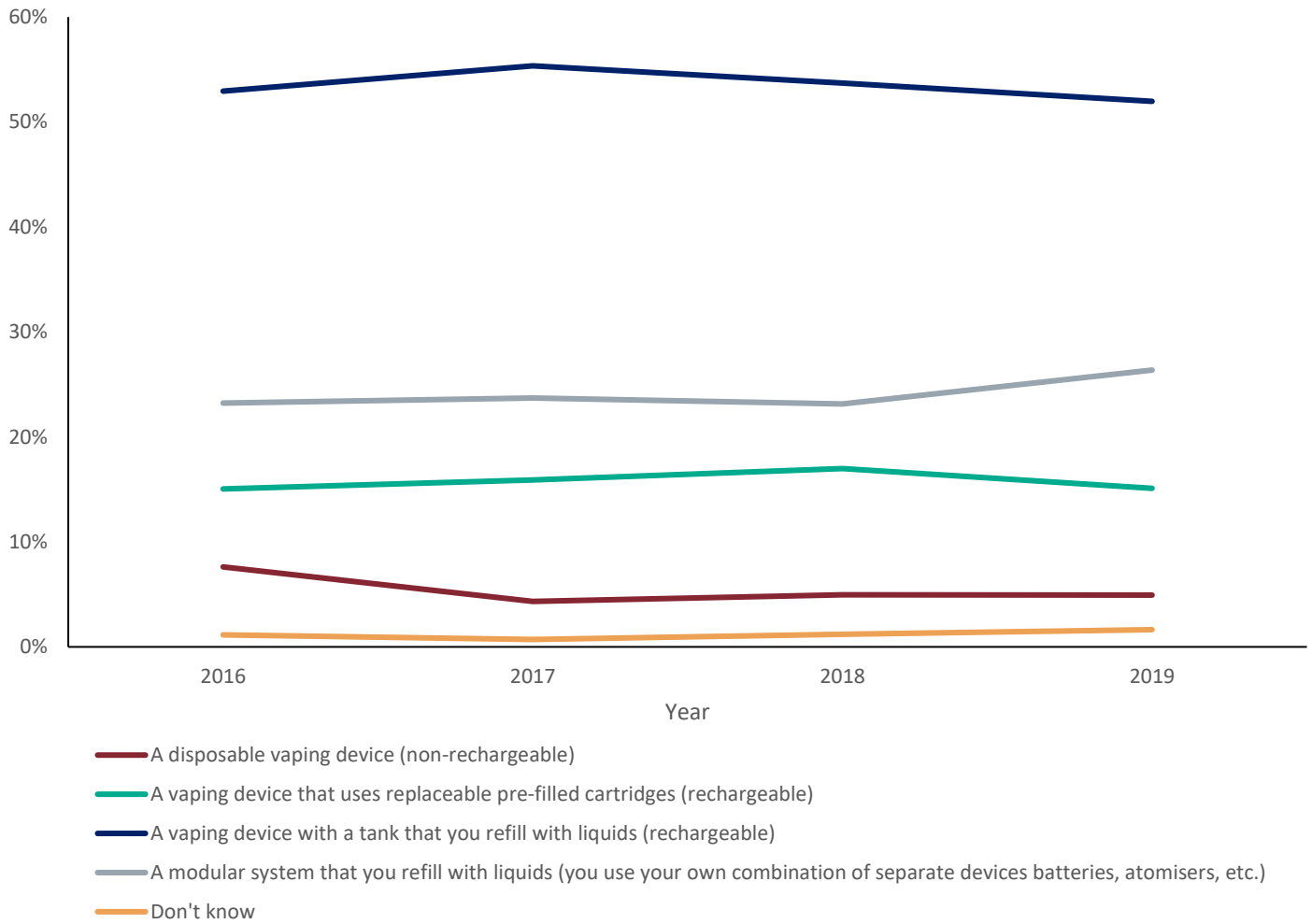
Notes: Unweighted bases: 2016 = 494; 2017 = 1,060; 2018 = 1,047; 2019 (to November) = 888 (no data available prior to 2016). Current vaping was "Current use for any reason".

Figure 30: Device type by socio-economic status among current vapers; England, 2019 (STS, weighted data)
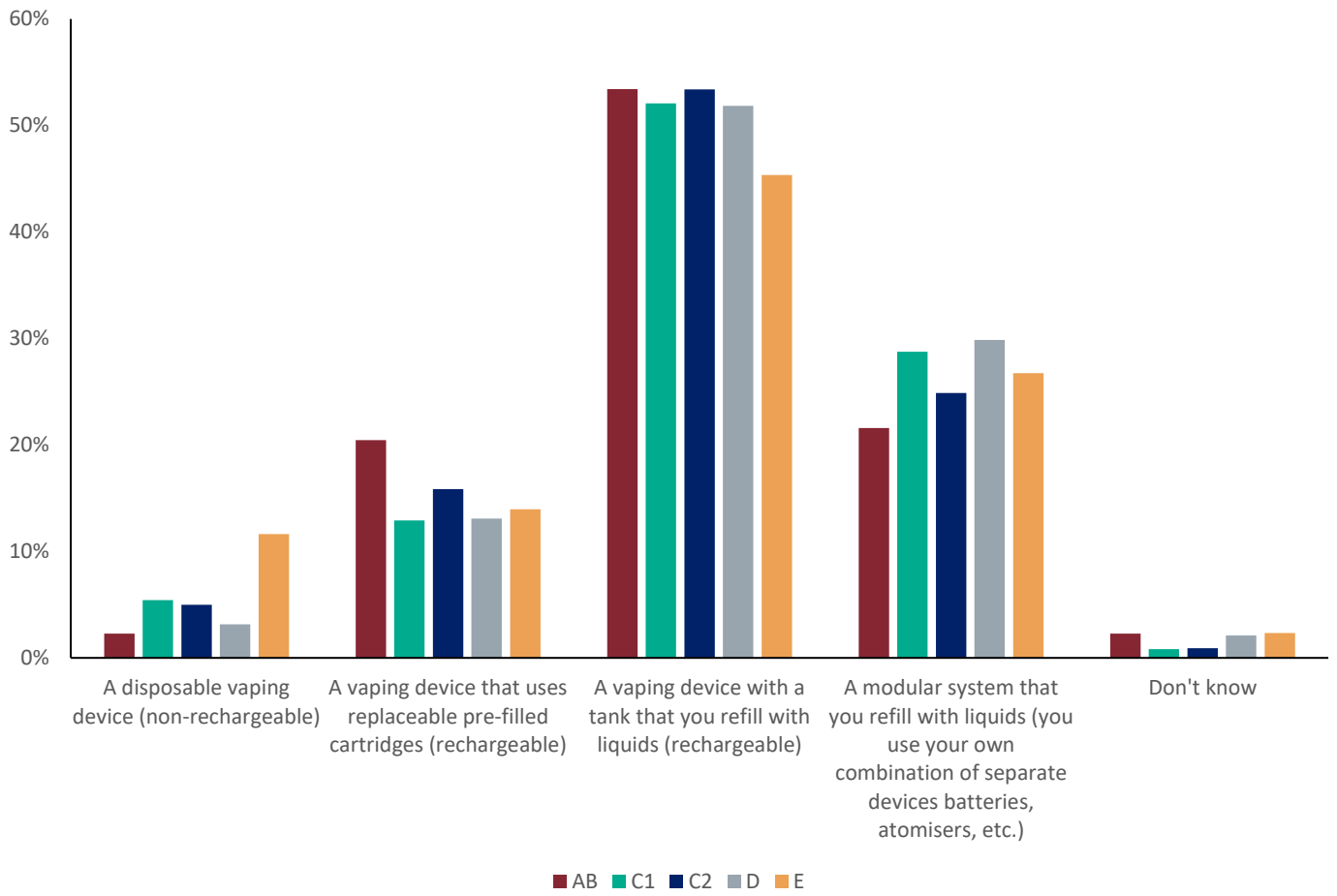
Notes: Unweighted base = 888.
Current vaping was "Current use for any reason".

Figure 31: Device type by smoking status among current vapers; England, 2019 (STS, weighted data)
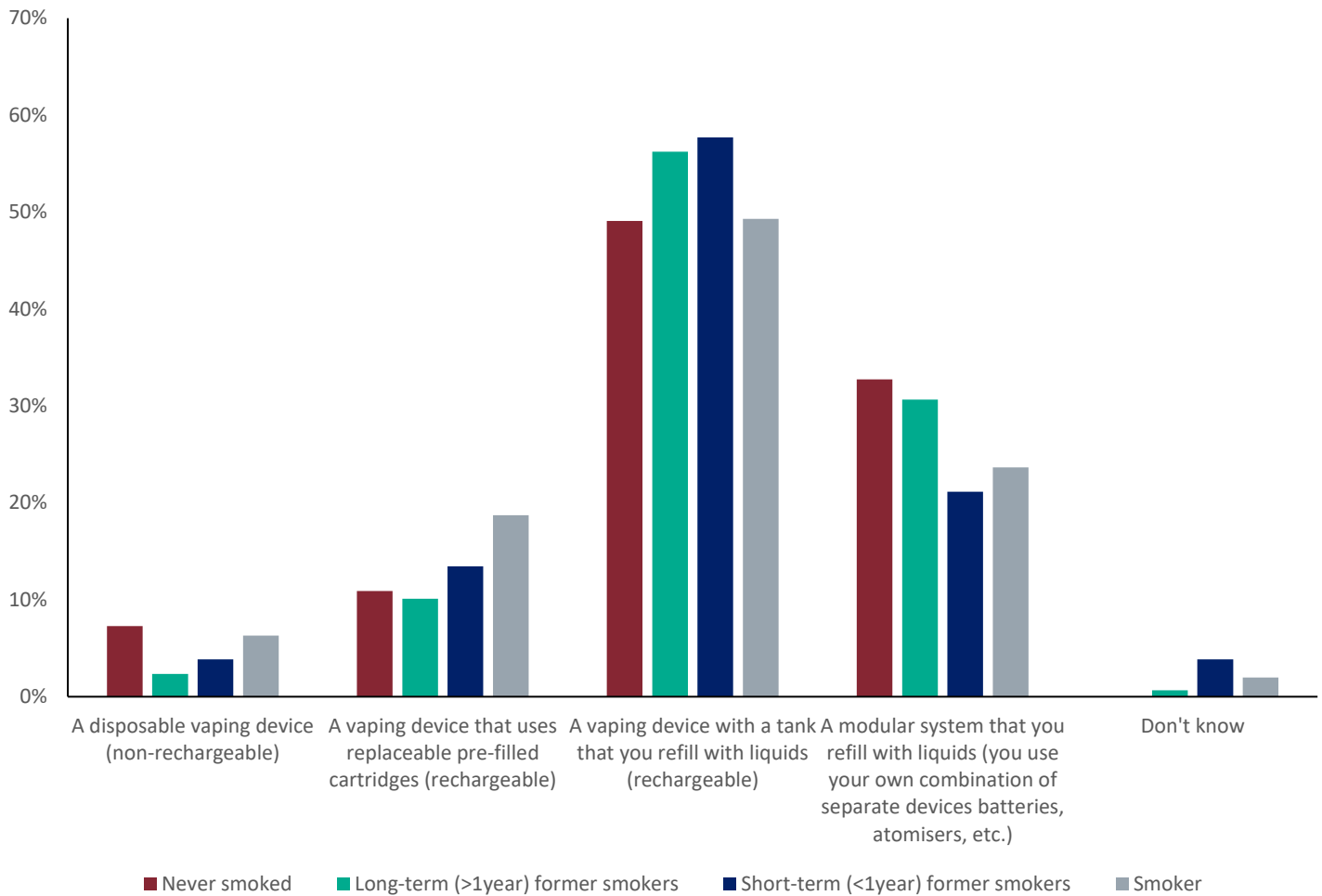
Notes: Unweighted base = 888.
Current vaping was "Current use for any reason".

Nicotine strength

Thirteen percent of STS participants said they used no nicotine in their vaping devices. The most common strength of nicotine in e-liquids was 6mg/ml (0.6% nicotine) or less, with 45.5% preferring this strength compared to 12.9% who preferred liquids containing 7mg/ml to 11mg/ml of nicotine, 21.8% who preferred 12mg/ml to 19mg/ml and just 3.5% who preferred a nicotine strength of over 20mg/ml (STS, Figure 32). A nicotine strength of 6mg/ml or less was the most common option across age groups. Nicotine strengths over 12mg/ml appeared to be more popular among people aged over 34 than in younger age groups (Figure 33). There were few differences in preferences for nicotine strength between smokers and former smokers (Figure 34), the most popular nicotine concentration was 6mg/ml regardless of smoking status.

Figure 32: Nicotine strength by year among current vapers; England, 2016 to 2019 (STS, weighted data)
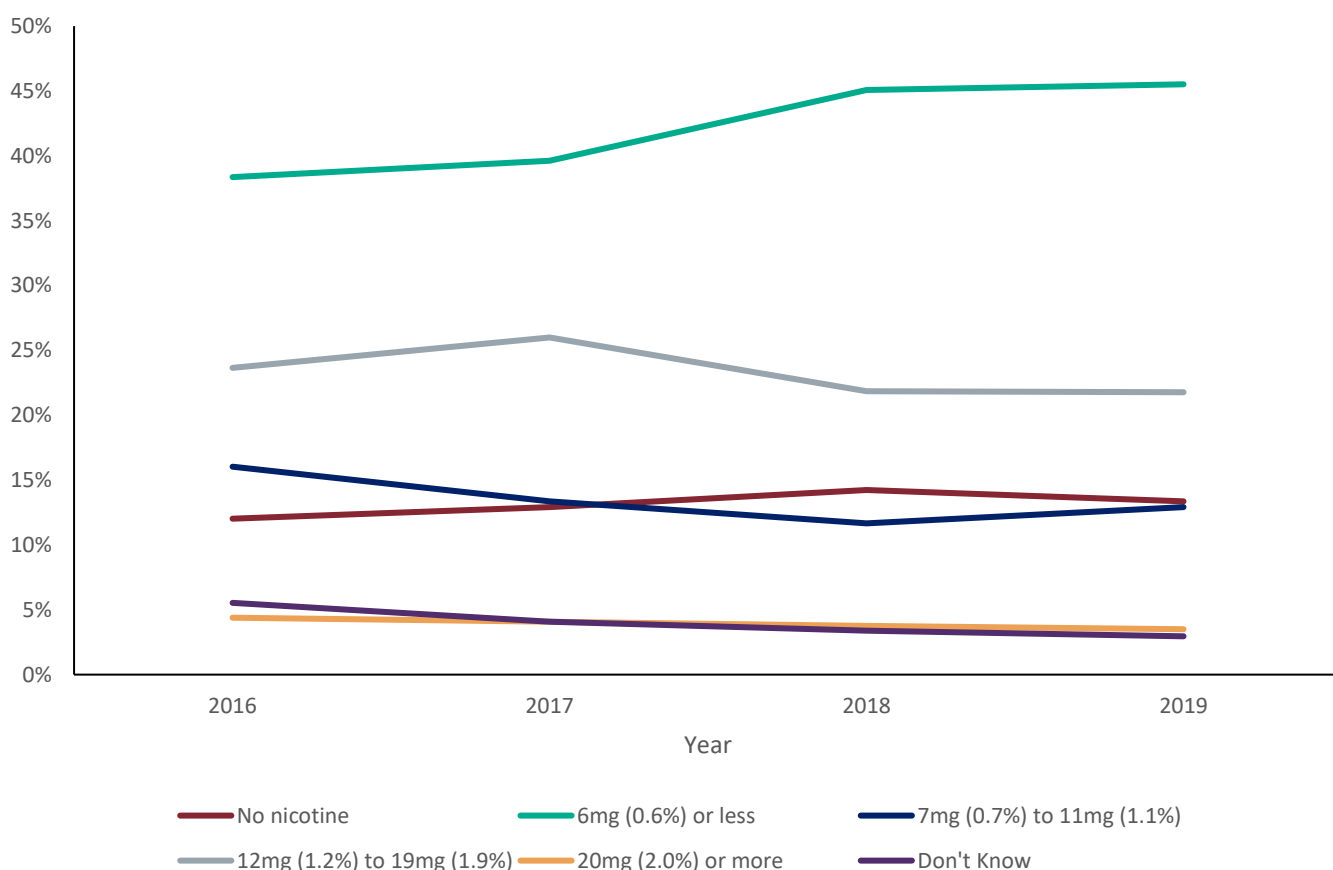
Notes: Unweighted bases: 2016 = 494; 2017 = 1,060; 2018 = 1,047; 2019 (to November) = 888.
Current vaping was "Current use for any reason".

Figure 33: Nicotine strength by age among current vapers; England, 2019 (STS, weighted data)
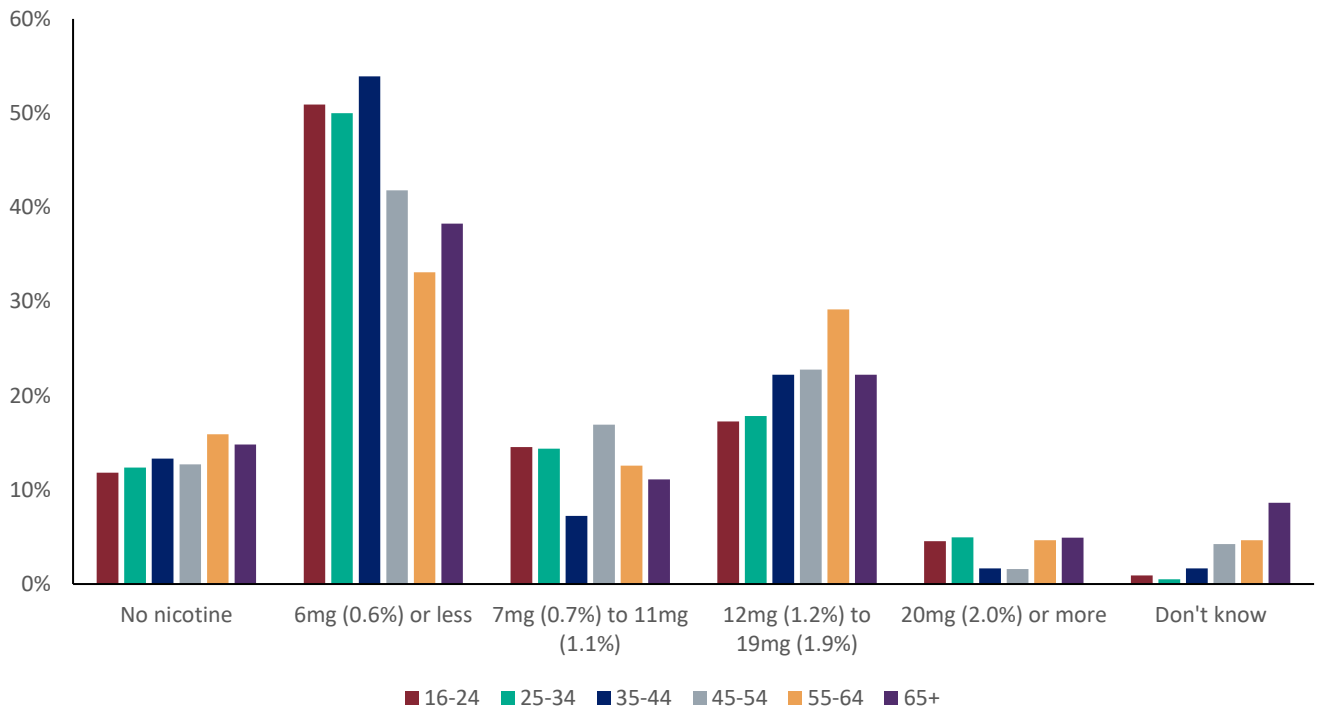
Notes: Unweighted base = 888.
Current vaping was "Current use for any reason".

Figure 34: Nicotine strength by smoking status among current vapers; England, 2019 (STS, weighted data)
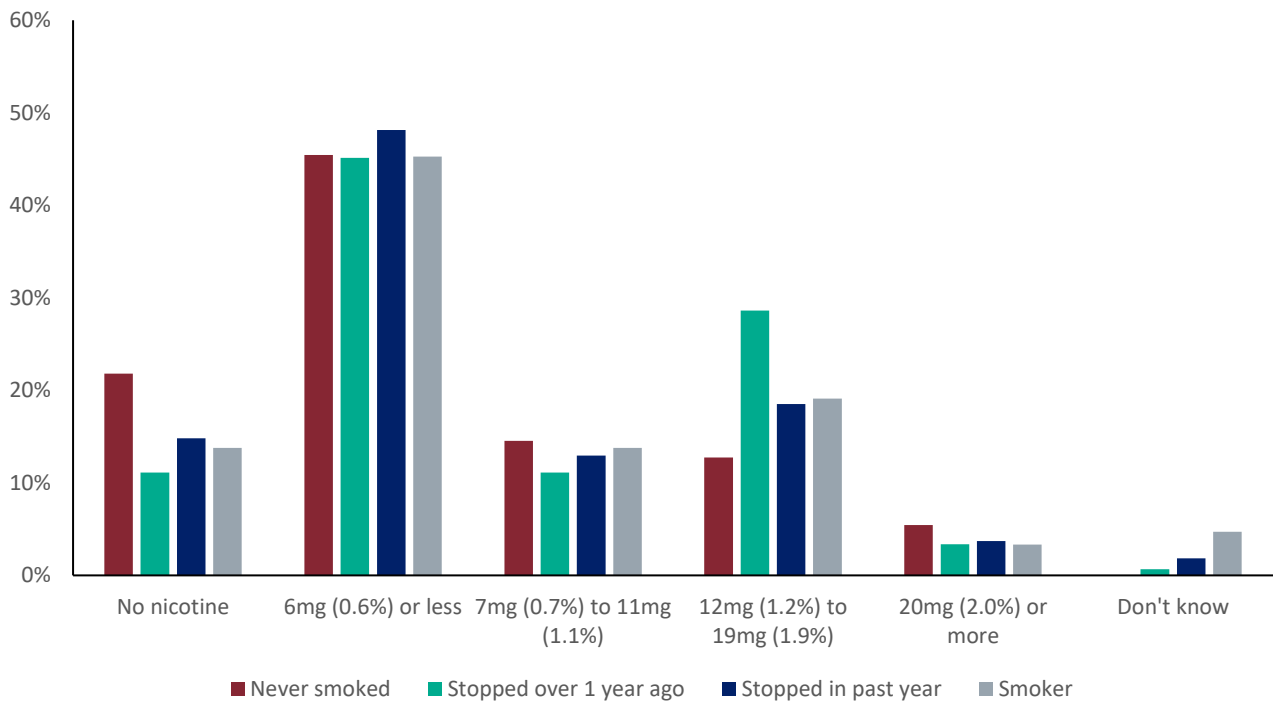
Notes: Unweighted base = 888. Current vaping was "Current use for any reason".

The data in Table 13 suggest that people tend to reduce, rather than increase the strength of nicotine over time with the majority (Table 13) reporting that the strength of liquid they used had remained the same since they first vaped. Around 40% reported it had decreased and between 2% (OPN) and 10% (ASH-A) said the strength of e-liquid they used had increased.

Table 13: Change in nicotine strength since started to vape among current vapers; Great Britain, 2018 (OPN, weighted data), England, 2019 (ASH-A, weighted data)

Change in nicotine strength	OPN 2018	ASH-A 2019
Stayed the same	54.4	51.7
Decreased	40.4	38.1
Increased	2.1	9.7
Varied	3.1	Not a response option

Notes: Unweighted bases: ASH-A = 755; OPN = 300.
ASH-A: Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.
OPN: Current vaping is people who answered "yes, I currently use one" to a question about whether they had ever vaped.

Flavoured e-liquids

The most popular flavour category among adults in the ASH-A survey was fruit (Figure 35), preferred by nearly a third of current vapers. Tobacco flavours were preferred by 1 in 4 and menthol/mint by 1 in 5. Under 5% preferred no flavour, sweet or candy flavours and tobacco menthol (combined) flavours.

Figure 35: Flavour preferences among adults who currently vape; England, 2019 (ASH-A, weighted data)
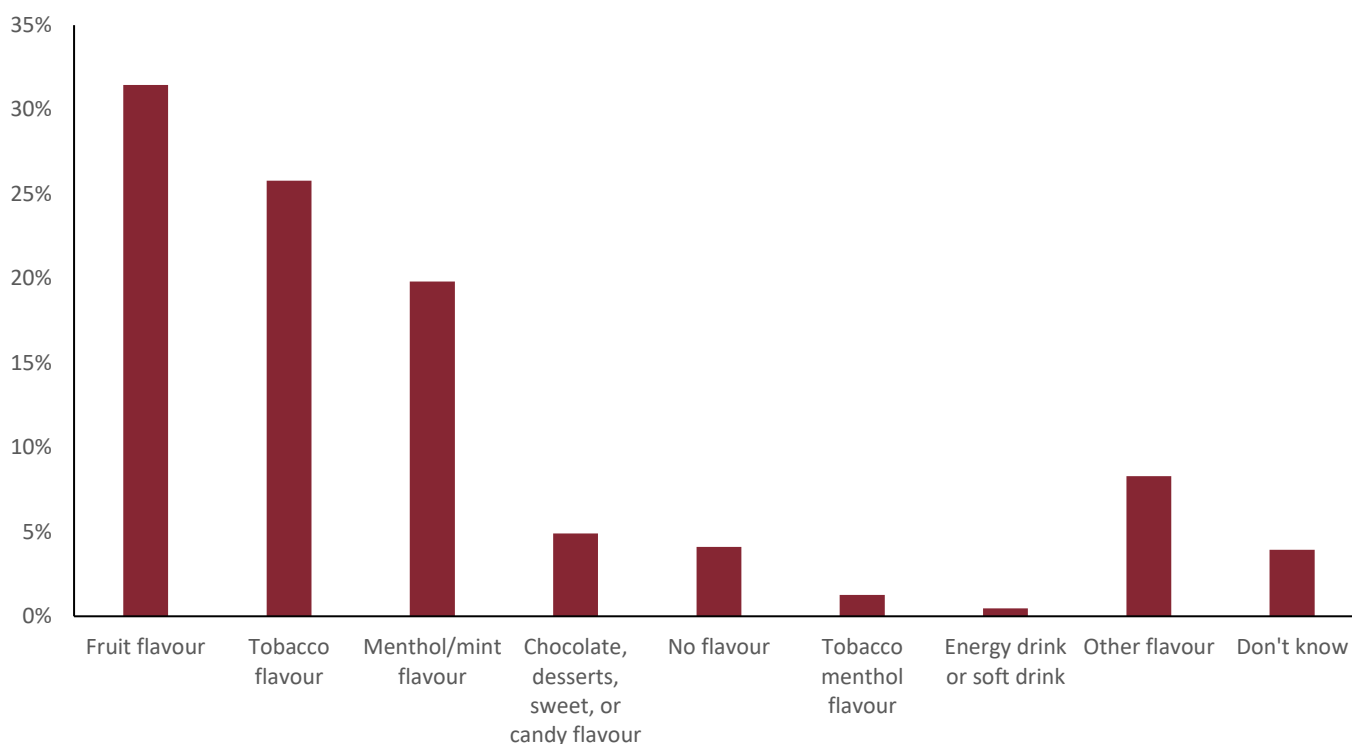
Notes: Unweighted base = 699. Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

The effect of a ban on flavoured liquids was also explored in the ASH-A 2019 survey where participants were asked what they thought they would do if flavours were no longer available. Around a quarter said they would still try to get flavours suggesting they would purchase from illicit distributers (Figure 36). Just under 1 in 10 vapers who use flavoured liquids said they would stop vaping, just under 1 in 5 said they would either smoke more tobacco or return to smoking tobacco. One in 10 said they would make their own flavoured e-liquids. It is important to note that the data for this analysis were collected before the recent incidences of lung injury in the US (the reasons for this are described in Chapter 1), a situation that may have altered vapers' perceptions of illicit markets or homemade vaping products. The data do, however, demonstrate some negative consequences that might result from a ban on flavoured e-liquids.

Figure 36: Potential effect of a ban on flavoured e-liquids 2019 for vapers who used flavoured liquids; England, 2019 (ASH-A; weighted data)
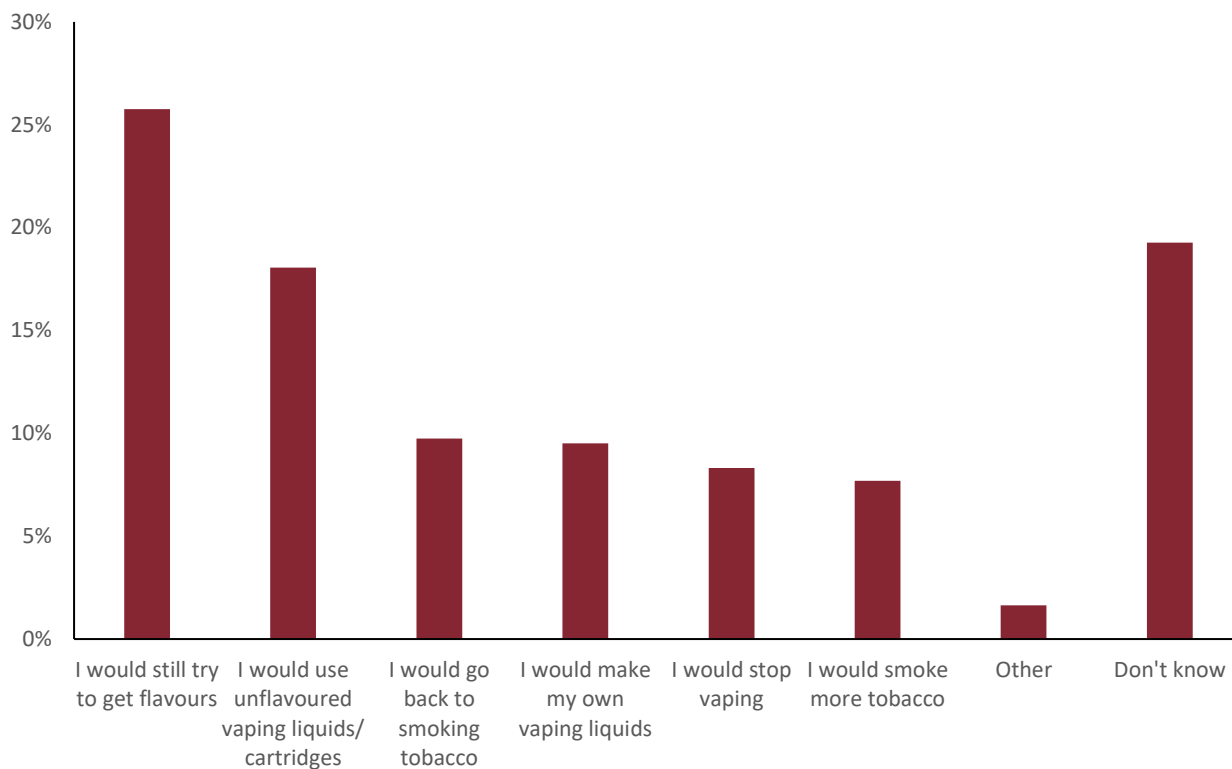
Notes: Unweighted base = 649.
Current vaping refers to people who had tried vaping products and who still used them, excluding those who no longer vaped.

Harm perceptions

An estimated 34.4% of current smokers in 2019 thought that vaping was less harmful than cigarettes, a figure that has declined since 2014 when 45.2% held this view (STS, Figure 37). The proportion of smokers who thought that smoking and vaping were equally harmful has increased from 26.1% in 2014 to 41.8% in 2019. In 2019, 14.2% said that vaping was more harmful than smoking and 9.6% said that they did not know about the comparative harms. This means most smokers believe that vaping is as harmful, or more harmful than smoking. It is of concern that negative beliefs about the harms from vaping might prevent smokers from switching to vaping and they would therefore continue to be exposed to the extremely high levels of harm caused by smoking.

Figure 37: Harm perceptions about vaping among current smokers; England, 2014 to 2019 (STS, weighted data)
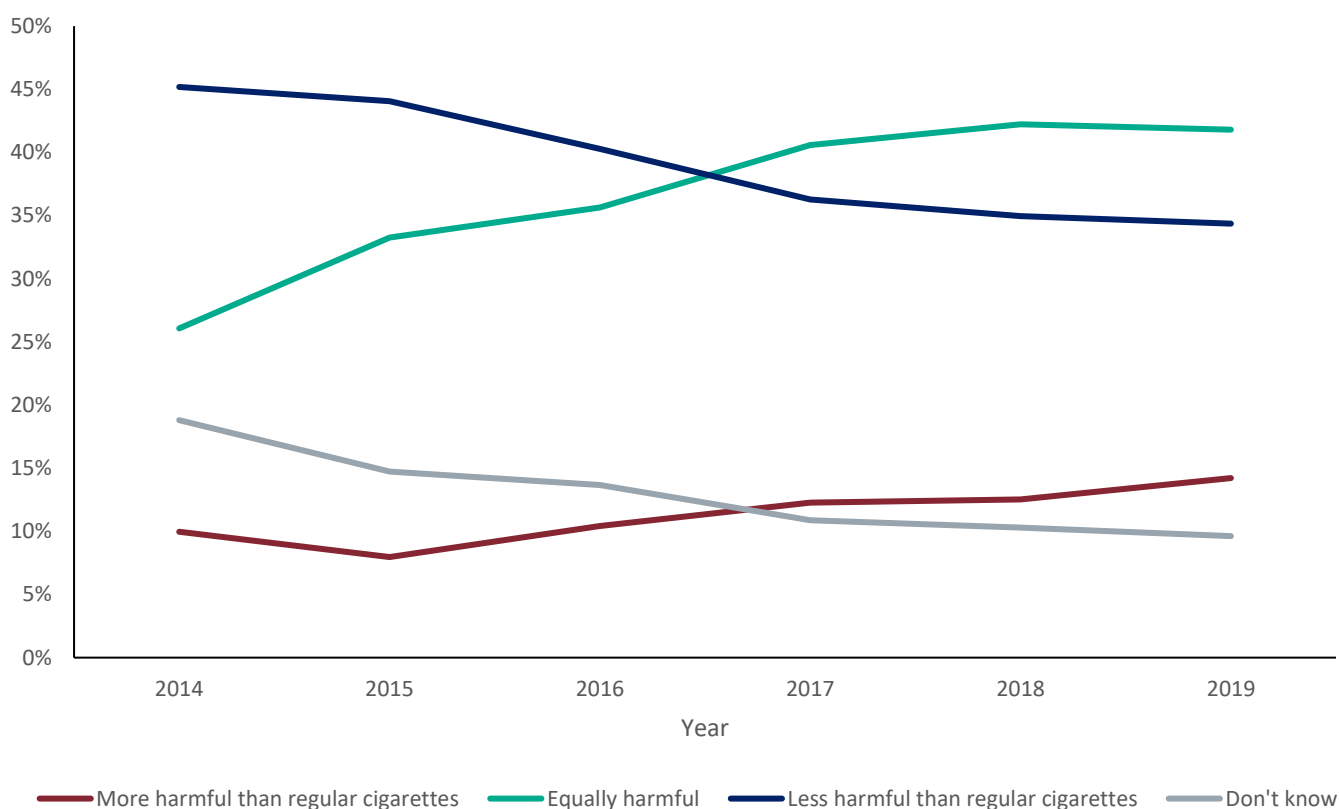
Notes: Unweighted bases: 2014 = 670; 2015 = 7,961; 2016 = 3,706; 2017 = 3,410; 2018 = 3,550; 2019 (to November) = 2,943. Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily.

Figures 38 and 39 break down harm perceptions among current smokers by vaping status. Among smokers who vape, the proportion (39.7%) who thought that vaping was equally harmful as smoking was a little lower than among smokers who do not vape (46.4%). However, among smokers who vape, only 5.1% thought that vaping was more harmful than smoking, compared with 23.2% among smokers who do not vape. The proportion of smokers who do not vape and perceive vaping to be more harmful than smoking increased steeply in 2019. It is possible that this has been influenced by the vaping injuries reported in the US (and described in Chapter 1). It will be important to continue to assess these changes in the light of emerging evidence as to the causes of these injuries. It will also be important to assess whether these perceptions have deterred people from using vaping products to help them quit smoking.

Figure 38: Harm perceptions of vaping products among current smokers who do not vape; England, 2015 to 2019 (STS, weighted data)
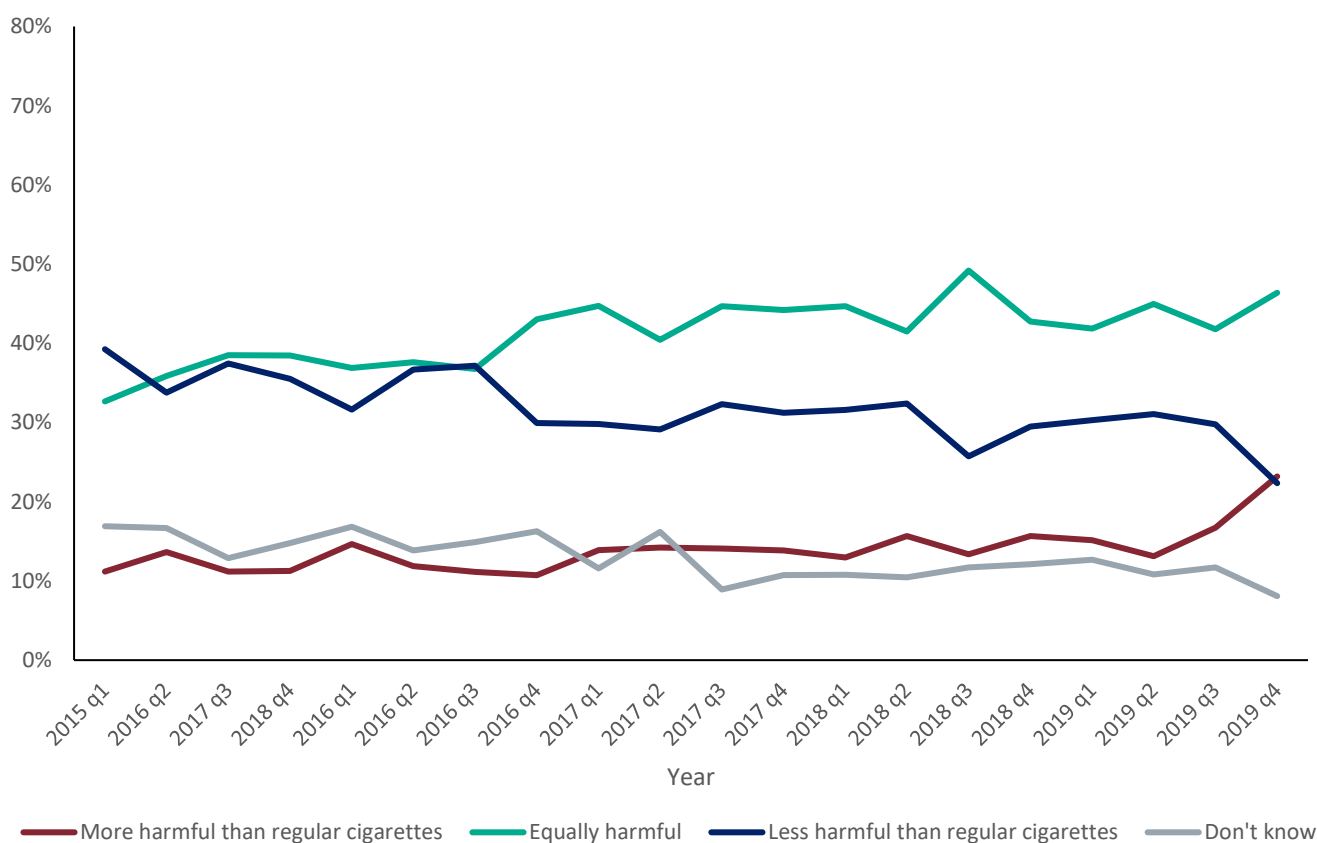
Notes: Unweighted bases: 2015 = 3,048; 2016 = 2,897; 2017 = 2,713; 2018 = 2,817; 2019 = 2,345.
Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily.

98

Figure 39: Harm perceptions of vaping products among current smokers who do vape, England, 2015 to 2019 (STS, weighted data)
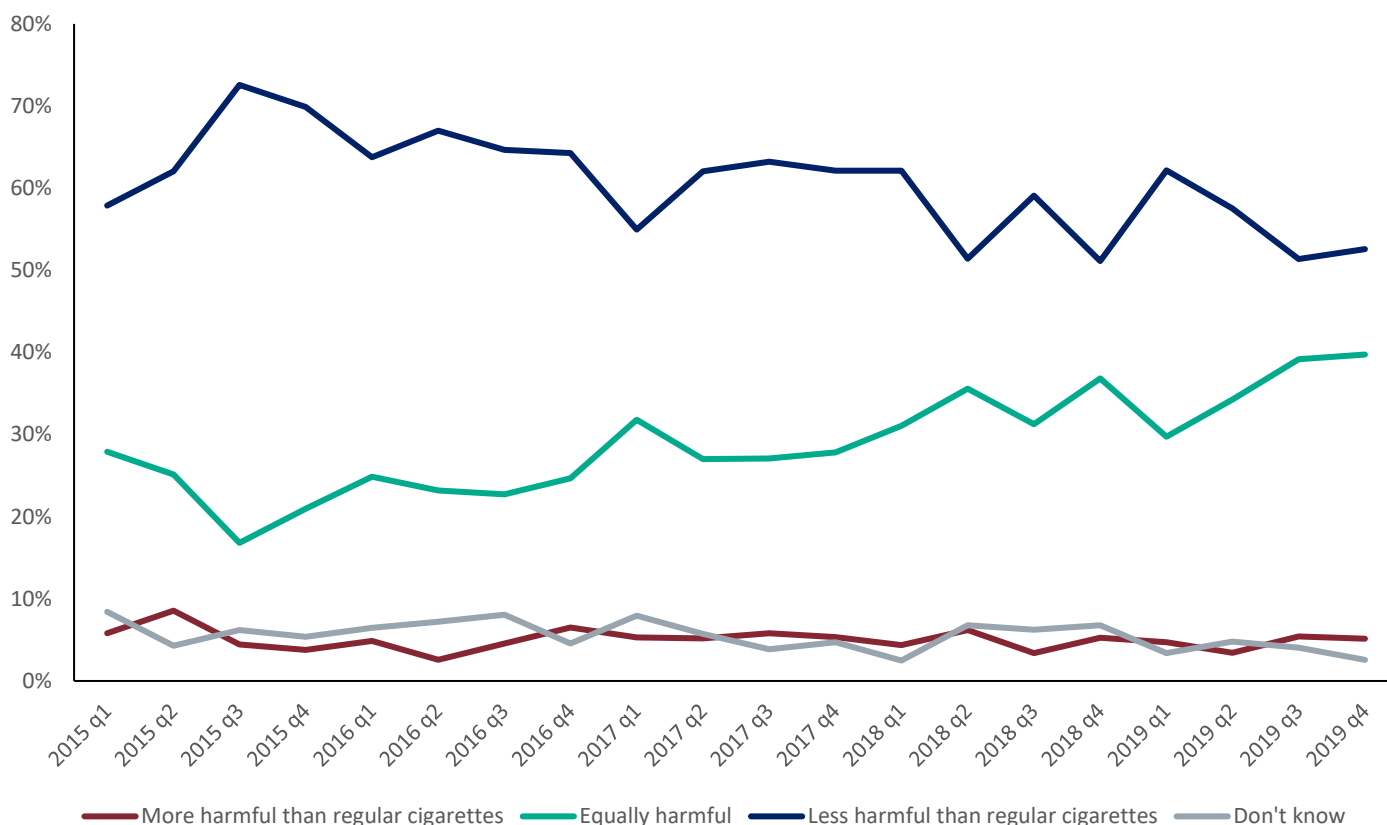
Notes: Unweighted bases: 2015 = 777; 2016 = 702; 2017 = 618; 2018 = 635; 2019 = 514.
Current cigarette smokers were those saying that they smoked daily or that they smoked but less than daily. Current vapers was "Current use for any reason".

Use of vaping products in English stop smoking services

Stop smoking services offer support that involves behavioural support with or without the use of pharmacotherapies (NRT, varenicline, bupropion) and vaping products in combination or alone.

Data are collected by NHS Digital [86] from local authority commissioned services every 3 months about the number of quit attempts; the number of quit attempts which led to successful quits at 4 weeks (self-reported and carbon monoxide (CO) verified); and principal measures of the service including intervention type, intervention setting and type of pharmacotherapy received. A smoker is counted as a 'self-reported 4-week quitter' if they are assessed (face to face or by telephone) 4 weeks after the designated quit date and declare that they have not smoked a single puff on a cigarette in the past 2 weeks. A smoker is counted as a 'CO-verified 4-week quitter' if they are a self-reported 4-week quitter and their expired-air CO is assessed 4 weeks after the designated quit date and found to be less than 10ppm. Treated smokers lost to follow-up are counted as non-quitters. The data provided by NHS Digital do not include

information about the demographic, smoking or vaping characteristics and therefore do not allow us to control for variables known to influence success rates such as a person's severity of tobacco dependence or type of vaping product used. Four week quit rates (both self-reported and CO verified) have been used to evaluate the effectiveness of stop smoking services since their inception in 1999 and are perceived to provide a good balance between accuracy and practicability [87]. These data also provide valuable information about the use of vaping products within the services.

Between April 2018 and March 2019, there were 236,175 quit attempts supported by stop smoking services. There were 123,800 self-reported successful quitters and 86,668 of these confirmed by CO verification. The number of quit attempts with each type of support and the self-reported quit rates are presented in Figure 40 (the CO-verified data are not available from NHS Digital by support used). As in previous years, the highest self-reported quit rates were observed when the quit attempt involved the use of a licensed medicine and a vaping product consecutively (72%), a vaping product only (67%) or a licensed medicine and vaping product concurrently (65%). It is important to note that all people using stop smoking services will receive behavioural support from those services, alongside any pharmacotherapy they receive, and that those using vaping products may differ from those using other products. Nevertheless, there is a recent randomised controlled trial that was carried out in English stop smoking services; this study included longer term follow-ups and found that smokers randomised to vaping products were nearly twice as likely to stop smoking as those randomised to NRT [88].

The NHS Digital data also indicate that, as in previous years, combination NRT remains the most popular type of pharmacotherapy used in a quit attempt (32% of the total pharmacotherapies received), whereas only 5% used a vaping product in a quit attempt. This contrasts with STS data in which the proportion of quit attempts that used vaping products varied from 27.6% in April 2018 to 28.9% in March 2019 [89]. This discrepancy can be attributed to the differences between the general population, and those seeking help from stop smoking services: the STS data indicate that over the same time period between 1.4% and 2.4% of general population smokers sought help from stop smoking services [89].

Figure 40: Self-reported 4-week successful quits by pharmacotherapy type in stop smoking services (April 2018 to March 2019)
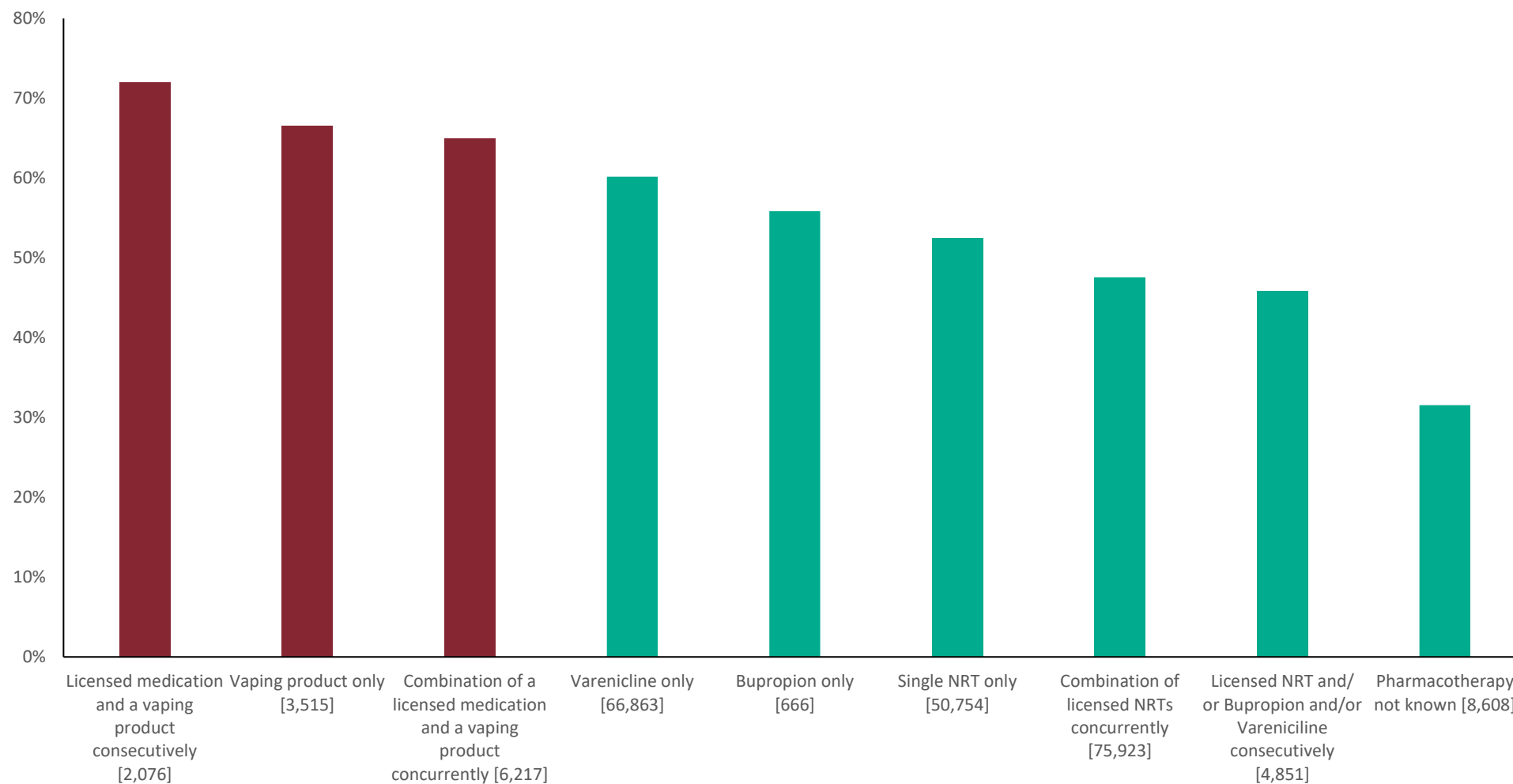
Notes: Figures in brackets represent the total number of quit attempts.

Vaping in quit attempts by region

Between April 2018 and March 2019, self-reported successful quits that involved the use of a vaping product either alone or in combination with licensed products, varied across regions. In London, 76% of quit attempts using a vaping product resulted in self-reported successful quits compared with 49% in the South West region (Figure 41).

Figure 41: Self-reported 4-week successful quits involving a vaping product* by region
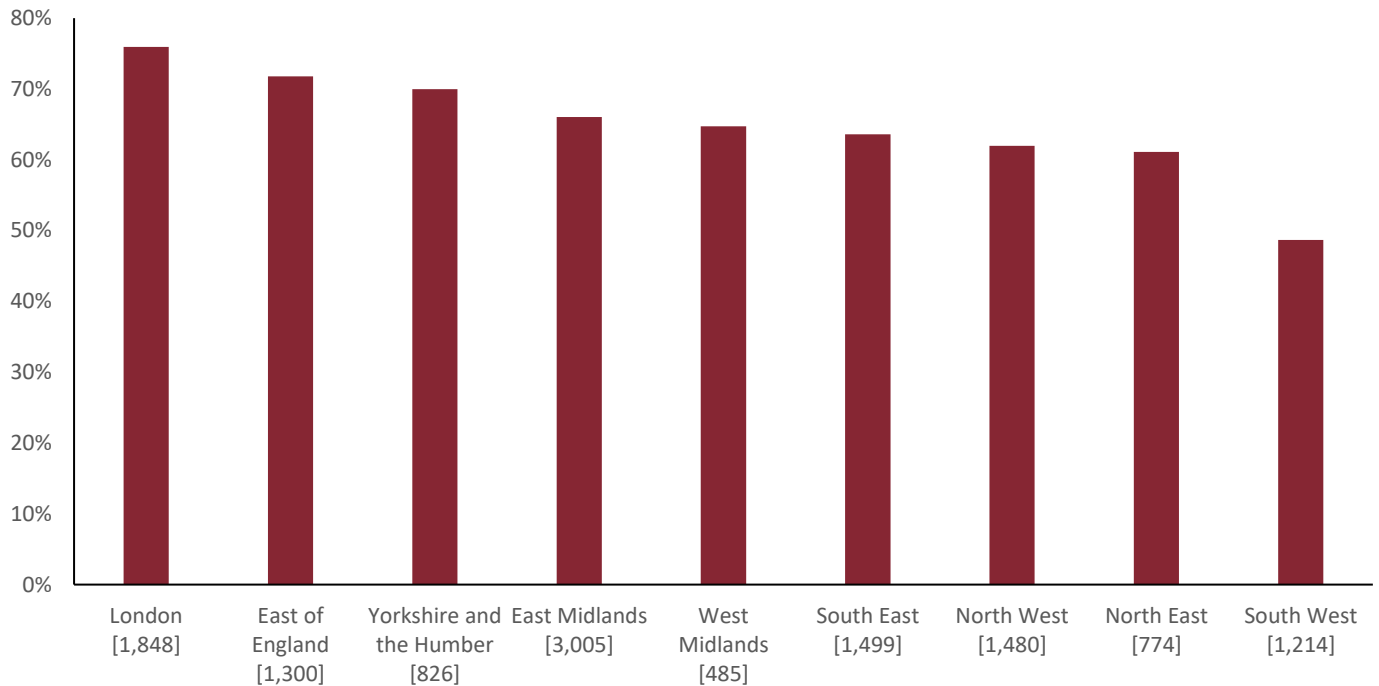
*Included vaping product alone or in combination with licensed medication concurrently or consecutively.
Figures in brackets represent the number of quit attempts that involved a vaping product.

International literature review of vaping among adults

The literature was searched and screened for evidence relating to vaping prevalence following the methods described in Chapter 2. The results are presented here separately for the US (Table 14) and for countries outside of the US (Table 15) due to the comparatively large amount of literature from the US.

Thirteen studies were identified that reported adult prevalence from nationally representative samples. Four of those presented data from the National Health Interview Survey (NHIS), 3 from the Population Assessment of Tobacco and Health (PATH) study, 2 from the Behavioural Risk Factor Surveillance System (BRFS) and 4 from other surveys (Table 14).

The most recent data were from the NHIS in 2018 [90-92] and reported that 3.2% of adults currently vaped daily, or some days, and that this had changed little since first measured in 2014 when it was 3.7%. Across surveys, vaping prevalence was higher in younger adults than in older adults, in contrast to the pattern found among adults in England described above where vaping prevalence was higher in middle-aged groups. Smoking prevalence in the NHIS survey was 16.7% in 2017 (Table 14).

The literature from outside of the US also comprised 13 articles with Germany the only country with more than one publication reporting prevalence (Table 15). One study by Laverty and colleagues [93] reported daily or weekly vaping prevalence in the 28 countries of the European Union in 2014 and in 2017. Overall, 1.8% of people in the EU vaped daily or weekly in 2017 which had changed little since 2014 (1.5%). The highest prevalence in 2017 was reported for the UK at 4.7%, with France the second highest prevalence at 3.7%. The lowest prevalence in 2017 was found in Bulgaria and Italy which reported 0.2% vaping prevalence and then Croatia, Romania and Sweden at 0.3% [93].

Other studies reported estimates ranging from 0.8% in China in 2013 to 2014 [94] to 7.6% of young men in Germany in 2016 who vaped in the past 30 days [66]. However, other studies from Germany reported 1.9% current vaping, 1.4% daily or weekly use [93] and 4% past 30-day use [95] respectively (Table 15).

Cross-country research is hampered by inconsistent methodologies, tools and questionnaire items. However, the Eurobarometer enables some comparisons to be made (as detailed above). Additionally, a recently published series of papers from the International Tobacco Control Policy Evaluation Project (ITC) makes international comparisons on a range of vaping issues.

Table 14: Peer-reviewed studies that reported adult vaping prevalence in the US

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Carwile et al., 2019 [96]	'adults'	Behavioural Risk Factor Surveillance System (BRFSS) 2016-2017	Daily or occasional use: 4.4%			
Mirbolouk et al., 2018 [97]	18+	Behavioural Risk Factor Surveillance System (BRFSS) 2016	Use every day or some days: 4.5% 33.5% of those daily users Prevalence decline with age, from 9.2% among 18- to 24-year-olds to 0.2% among 80+-year-olds			
King et al., 2018 [98]	18 to 25	Online survey, 2016	Past 30 days: 10.0%			
Sung et al., 2018 [99]	18+	National Adult Tobacco Survey, 2012-2014	Daily: 1.1% Some days: 1.7% Rarely: 2.8%			Cigarettes Daily: 13.6% Some days: 4.3% Cigars: Daily: 0.7% Some days: 1.2% Rarely: 3.3%
Roberts et al., 2018 [100]	18+	National Epidemiologic Survey on Alcohol and Related Conditions−Wave III, 2012 to 2013	Non-daily: 3.7% Daily: 1.1%			
Stallings-Smith, 2019 [101]	18+	National Health and Nutrition Examination Survey (NHANES), 2015 to 2016		20%		43%
McMillen et al., 2019 [102]	18+	PATH Wave 1 (2013 to 2014) and 2 (2014 to 2015)	Past 30-day use: Former smokers (quit at least 5 years ago): 1.0% Never smokers: 0.4%	Former smokers (quit at least 5 years ago): 4.3% Never smokers: 1.5%		

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Rezk-Hannah et al., 2019 [77]	18+	PATH Wave 2	Every day or some-day: 'E-hookah': 1.2% 'E-cigarettes': 5.6%	'E-hookah': 4.6% 'E-cigarette's: 22.5%		
Rodu et al., 2018 [103]	18+	PATH Wave 1	Every day: 1.0% Some days: 1.4%			Current smoking: 18% Current trier: 3.1%

Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Bao et al., 2019 [104] Dai & Leventhal, 2019 [105] QuickStats (Morbidity and Mortality Weekly Report (MMWR) [106] Wang et al., 2018 [107]	18+	National Health Interview Surveys (NHIS) 2014-2018	Use every day or some days Overall: 2014: 3.7% 2015: 3.5% 2016: 3.2% 2017: 2.8% 2018: 3.2% 18- to 24-year-olds: 2014: 5.1% 2015: 5.2% 2016: 4.7% 2017: 5.2% 2018: 7.6% 25- to 44-year-olds: 2014-2016 reported in graph only, no significant changes 2017:3.6% 2018: 4.3% 45- to 64-year-olds: 2014: 3.5% 2015: 3.3% 2016: 2.8% 2017: 2.4% 2018: 2.1% 65+ year-olds 2014: 1.4% 2015: 1.1% 2016: 1.0% 2017: 0.7% 2018: 0.8%			Any combustible tobacco product aged 18+: 2017: 16.7% Current cigarette smoking 18- to 24-year-olds: 2014: 16.7% 2018: 7.8%

Table 15: Peer-reviewed studies that reported adult vaping prevalence in countries other than the US

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Australia	Chan et al., 2019 [108]	18+	National Drug Strategy Household Survey (NDSHS) dataset 2016	Vape currently: 1.2% Use EC daily: 0.5%			
Austria	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.9% 2017: 2.6%			
Belgium	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.4% 2017: 2.7%			
Bulgaria	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.6% 2017: 0.2%			
China	Zhao et al., 2019	15+	China City Adult Tobacco Survey (CCATS) 2013-2014	Daily or non-daily: 0.8%			
Croatia	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.2% 2017: 0.3%			
Cyprus (Republic)	Laverty et al., 201 [93]8	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.8% 2017: 1.8%			
Czech Republic	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.6% 2017: 1.2%			
Denmark	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.8% 2017: 1.7%			
Estonia	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.6% 2017: 1%			
European Union	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.5% 2017: 1.8%	Ever use: 2014: 11.6% 2017: 14.6%		
Finland	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.7% 2017: 0.8%			

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
France	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 3.6% 2017: 3.7%			
Germany	Atzendorf et al., 2019 [95]	18 to 64	Epidemiological Survey of Substance Abuse 2018	Past 30 days: 4.0%			
Germany	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.1% 2017: 1.4%			
Germany	Kotz & Kastaun, 2018 [65]; Kotz et al., 2018 [109]	14+	Deutsche Befragung zum Rauchverhalten (DEBRA) [German Study on Tobacco Use] 2016-17	Current use: 1.9%	Ever use: 9.8%		28.3%
Germany	Orth et al., 2018[66]	18 to 25	BZgA-Alkoholsurvey 2016	Past 30-day e-cigarette use: Men: 7.6% Women: 3.4% Past 30-day e-shisha use: Men: 3.2% Women: 1.6%			Current regular or occasional smoker: Men: 29.4% Women: 22.5% Past 30-day use: Men: 29.7% Women: 23.5%
Greece	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	2014: 0.9% 2017: 2.3%			
Hong Kong	Jiang et al., 2019[110]	18 to 35	Online survey (convenience sample)	Past 30 days: 4.8%	16.1%		
Hungary	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.3% 2017: 0.6%			
Ireland	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 2.4% 2017: 1.9%			
Italy	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.1% 2017: 0.2%			

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Latvia	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.8% 2017: 0.8%			
Lithuania	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.2% 2017: 0.5%			
Luxembourg	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.8% 2017: 1.3%	Ever use: 1.08adjusted odds ratio (aOR)		
Malaysia	Ab Rahman et al., 2019 [111]	18+	National E-Cigarette Survey 2016	Past 30-day use: 3.2% Vape currently daily: 0.8%	Ever use: 11.9%		Current smoker: 23.4%
Malta	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0% 2017: 1.9%			
Mexico	Zavala-Arciniega et al., 2018 [68]	18 to 65	National Survey of Drugs, Alcohol and Tobacco Use (ENCODAT) 2016	Non-smokers (ex and never): 0.3% Smokers: 5%	Non-smokers (ex and never): 0.3% Smokers: 18%		19.9%
Netherlands	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.4% 2017: 1.3%			

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
New Zealand	Oakly et al., 2019 [112]	15+	Health and Lifestyles survey 2016	At least monthly current use: Overall: 1.8% Never smokers: 0.0% Current smokers: 7.3% Recent ex-smokers: 9.1% Long-term ex-smokers: 0.9% Daily use: Overall: 1.0% Never smokers: 0.0% Current smokers: 3.1% Recent ex-smokers: 9.0, Long-term ex-smokers: 0.7%	Ever use: 17.1%		At least monthly: 15.3%
Poland	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.9% 2017: 0.9%			
Portugal	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.2% 2017: 0.5%			
Romania	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.5% 2017: 0.3%			
Serbia	Kilibarda et al., 2019 [81]	18+	A stratified three stage, random, nationally representative survey 2017	Vape currently Overall: 0.5%	Ever use 2019: 10.7%		
Slovakia	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.1% 2017: 0.4%			
Slovenia	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.5% 2017: 0.4%			
Spain	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 1.6% 2017: 1%			
Sweden	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 0.3% 2017: 0.3%			

Location	Study	Age	Data source and year	Prevalence of current vaping	Prevalence of ever vaping	Vaping prevalence other	Smoking prevalence
Taiwan	Chen et al., 2018 [113]	18 to 64	National Survey of Substance Use 2014	Past Year: 1%	2.2%		Past year: 20.5%, Ever: 28.2%
UK (Kept here for comparison)	Laverty et al., 2018 [93]	15+	Special Eurobarometer for Tobacco Survey 2014, 2017	Vape daily or weekly: 2014: 3.6% 2017: 4.7%			

Conclusions

Summary of findings

- current vaping prevalence (any current use) among adults in England has remained stable since 2014, and in 2019 was between 5% and 7%
- current vaping prevalence among smokers varied between 14% and 20% across surveys, again showing little change since 2014
- current vaping prevalence among former smokers has continued to rise and was 12% to 13% in 2019
- vaping remains most common among smokers and former smokers, with less than 1% of people who have never smoked currently vaping
- the proportion of current smokers who have not tried vaping products remained at 37% between 2018 and 2019
- smoking among adults in England has continued to decline over the past 10 years and in 2019 was around 15%
- vaping prevalence is highest among people in more disadvantaged socio-economic groups, reflecting their higher levels of smoking
- perceptions of harm from vaping among smokers are increasingly out of line with the evidence. The proportion who thought vaping was less harmful than cigarettes declined from 45% in 2014 to 34% in 2019. These misperceptions are particularly common among smokers who do not vape
- most adults use vaping products to help them quit smoking
- vapers said that banning flavoured liquids would deter them from using vaping products to help them quit or reduce their smoking. It could also push current vapers towards illicit products
- as in previous years, data from stop smoking services in England suggest that when a vaping product is used in a quit attempt, either alone or with licensed medication, success rates are comparable to, if not higher than, licenced medication alone
- where international information is available, adult vaping prevalence in England appears to be higher than in other countries

Implications

- the data presented here suggest that vaping has not undermined the declines in adult smoking
- increasingly incorrect perceptions among the public about the harms of vaping could prevent some smokers using vaping products to quit smoking
- a ban on flavoured e-liquids could have adverse effects and unintended consequences for smokers using vaping products to quit. It should only be considered with caution

Chapter 5: Systematic review of vaping among people with mental health conditions

This chapter presents a systematic review of the current evidence about vaping among people with mental health conditions (MHC). It includes a brief overview of smoking among people with MHC; the methods of the review; the prevalence and use of vaping products; the effect of vaping products on quitting or reducing tobacco smoking; the benefits and harms of their use; and barriers and facilitators of their use. The chapter ends with implications for use in this population. Please note the terminology section in Chapter 1 for definitions of vaping used in this report.

Smoking among people with mental health conditions

Among adults in England with MHC, tobacco smoking prevalence remains around 50% higher when compared with those who do not have MHC [114]. Heavy smoking and severe dependence is common in these groups [115]. High rates of smoking are influenced by psychosocial, environmental and societal factors, in addition to the long-standing supportive smoking culture within health services [116, 117].

Smoking is one of the main contributors to early death and poor health among people with MHC. People with schizophrenia, bipolar disorder, depression and anxiety who smoke experience more severe symptoms of their illness and require higher doses of some psychotropic medicines than non-smokers because of the effects of tobacco smoke (not nicotine) on the metabolism of some medicines [118].

Smoking is also associated with poorer treatment outcomes; compared with non-smokers with MHC, smokers spend more time in hospital and less time out of hospital [119]. People with MHC have a great deal to gain from stopping smoking, including longer life expectancy, improved mental and physical health, lower doses of some psychotropic medicines and better financial health [115, 120, 121].

Licensed stop smoking aids and behavioural interventions are effective for helping people with MHC stop smoking [122-125]. However, quit rates are lower compared to smokers without MHC: a large, multicentre RCT that

examined the safety and efficacy of licensed cessation aids in smokers with and without MHC, reported that of the smokers who were prescribed varenicline, 17% with psychosis and 19% of those with a mood disorder quit smoking at 6-month follow-up compared with 25% of smokers without MHC [126]. For those in the trial who were prescribed a NRT patch,10% of smokers with psychosis, and 13% of those with a mood disorder quit at 6 month follow-up compared with 18% of smokers without MHC [126]. However, opportunities to quit are often hampered by poor availability of support, knowledge, attitudes and competence of the health workforce and poor treatment engagement [121, 127, 128].

In our previous evidence reviews we highlighted the opportunity for vaping products to help tackle high smoking rates among people with MHC and the lack of research in this area [3, 4]. As the evidence base grows for the effectiveness of vaping products to help people from the wider general population stop smoking [88, 129, 130], it is important to explore their efficacy and safety among people with MHC.

Objectives

Our objectives addressed the following review questions (RQ):
Among people with MHC:

1. What is the prevalence of vaping?
2. What are the characteristics of vaping, eg. device used, frequency of use, nicotine strength and flavours used?
3. What are the effects of vaping on smoking cessation or reduction?
4. What are the physical and mental health related adverse effects of vaping?
5. What are the benefits of vaping on physical and mental health outcomes?
6. What are the reported barriers to, and facilitators of, vaping?

Methods

Protocol and registration

The review adhered to PRISMA guidelines and the protocol was registered with the international prospective register of systematic reviews (PROSPERO), registration number-CRD42019137747.

Eligibility criteria

Criteria for including studies in this review included;

Types of participants: The population of interest was adults (18 and over) with MHC. We included studies of participants who either:

- experienced a current or past diagnosis of a mental disorder (eg. depression or anxiety, schizophrenia according to ICD-10/11 [131] or DSM-5) [132], which could be self-reported, validated with a rating scale or unvalidated (this differed from the inclusion criteria in our pre-registered protocol, as few studies reported validated diagnosis data)
- experienced current or past serious psychological distress (SPD), validated with an appropriate rating scale, eg. Kessler Screening Scale for Psychological Distress [133]

For this report, the abbreviation 'MHC' refers to all the above. We define how MHC was categorised for each study in appendix B. Participants from clinical and non-clinical populations, national and non-national survey samples, conducted in any country, were included.

For RQ3 (effects of vaping on smoking cessation or reduction), we included studies where participants with MHC were either motivated or unmotivated to stop smoking. For RQ6 (barriers and facilitators), we also included studies that assessed health professionals' perceptions of vaping among people with MHC.

Types of interventions: Any type of vaping product used by people with MHC.

Types of comparator/controls: Comparator or control groups were not required for study inclusion but are reported where they existed (eg. use in participants with MHC compared with participants without).

Types of outcome measures: For RQ1 (prevalence), studies that reported prevalence of ever or current vaping among people with MHC were included. Also, where reported, we included prevalence studies that assessed vaping by smoking status. The prevalence of MHC among people who vape were not included, unless they contained information to answer RQ1 or any of the other questions. For RQ3 (effects on smoking cessation or reduction), cessation and reduction outcomes at the longest follow-up with biochemically validated self-reported abstinence or reduction were included. For RQs 4 and 5 (physical and mental adverse effects and benefits)

self-reported or objectively measured adverse events and benefits to mental or physical health after being exposed to a vaping product were included.

Types of studies: We included the following types of study designs: randomised, quasi-randomised, non-randomised studies; single group pre-post-test study designs; cohort, case control, longitudinal and cross-sectional studies; mixed methods and qualitative studies.

Information sources and search methods

Searches were conducted by one reviewer and screening for eligibility was conducted by 2 reviewers. The following databases were searched on 10 September 2019 with no specified start date (ie. all literature published before 10 September was included); Ovid Medline, CINAHL, Embase, PubMed, PschINFO. We included peer-reviewed published papers and those in press. English, French, German and Italian publications were included. Non-peer-reviewed literature (eg. posters, conference abstracts and PhD theses) were excluded. The search terms were based on those used in our previous evidence reviews [3-5], with the addition of mental health related terms. The Medline search terms are included in appendix A.

Data collection process and data items

Data were extracted independently by 2 reviewers. We extracted data on: authors, date of publication, study design, eligibility criteria, study participant characteristics (eg. sex, age, ethnicity) and data regarding each RQ.

Risk of bias in individual studies

Risk of bias for prevalence studies was appraised using a tool developed by Hoy et al. [51]. Observational studies (non-prevalence) were appraised using the Newcastle-Ottawa-Scale, adapted for cross-sectional studies [134, 135]. Intervention studies were assessed using MINORS (Methodological Index for Non-randomised studies) [136] and criteria recommended by Villanti et al. [54]; qualitative studies were appraised using COREQ [53].

Summary measures and synthesis of results

The findings are described narratively. Proportions are reported for prevalence, characteristics of use and effect on cessation/reduction. Results were not pooled, and a meta-analysis was not conducted as methods of

individual studies varied greatly (eg. type of survey and participants, year conducted, location of the study and method of data collection).

Results

Study selection

Our database searches identified 4,509 non-duplicate records. We screened all records and retrieved the full text papers of 59 potentially relevant studies. After screening and checking full texts, we identified 31 eligible studies for inclusion. Figure 42 presents the PRISMA flow diagram.

Title and abstract screening were performed by one reviewer, with 10% checked by a second reviewer. Full text screening for inclusion was performed by 2 reviewers, with a Cohen's kappa coefficient of 0.90, which indicates high agreement.

Study characteristics

England

Design
Three of the included studies were conducted in England [128, 137, 138] (Table 16). One was a single group pre-post-test study to evaluate the effect of a vaping product intervention [137], one was a cross-sectional survey [128] and the third was a qualitative study [138].

Participants
Hickling et al. [137] recruited smokers with a severe mental illness (ie. schizophrenia, schizoaffective and bipolar disorder). Simonavicius et al. [128] recruited stop smoking advisers in English stop smoking services and Smith et al. [138] recruited mental health professionals working in primary and secondary mental health services.

Outside the UK

Twenty studies were conducted in the US [107, 139-157]; 4 in Australia [158-161], one in New Zealand [162], one in Japan [163], one in France [164] and one in Italy [165] (Table 16).

Design

Twenty-one were cross-sectional surveys [107, 139-151, 153-156, 159, 163, 164]; 3 were single group pre-post studies that described smoking abstinence or reduction between 4-weeks and 12-month follow-up [152, 157, 165]; one was a secondary analysis of a randomised controlled trial (RCT) comparing a vaping product with NRT [162], 2 were qualitative studies [160, 161] and one was a mixed-methods study [158].

Participants

Seven studies recruited nationally representative participants [107, 143, 145, 151, 154-156]; 8 studies recruited from regional or state-wide settings [140, 142, 147, 149, 150, 162-164]; 11 studies recruited patients from clinical settings [139, 141, 144, 146, 148, 152, 153, 157, 158, 161, 165] and one study included both people with MHC and health professionals [160]. One study recruited only health professionals [159].

Details of the study characteristics are included in Table 16. How each study defined i) ever and current vaping; ii) smoking status; and iii) MHC are described in appendix B.

Figure 42: PRISMA flow diagram for systematic review of vaping in people with a mental health condition

Records identified through database searching (n = 7,560)

Additional records identified through other sources (n = 1)

Records after duplicates removed (n = 4,590)

Records screened (n = 4,590)

Records excluded (n = 4,531)

Full-text articles assessed for eligibility (n = 59)

Full-text articles excluded (n = 28)

Studies included in quantitative synthesis (n = 31)

England (n = 3)
Non-UK (n = 28)
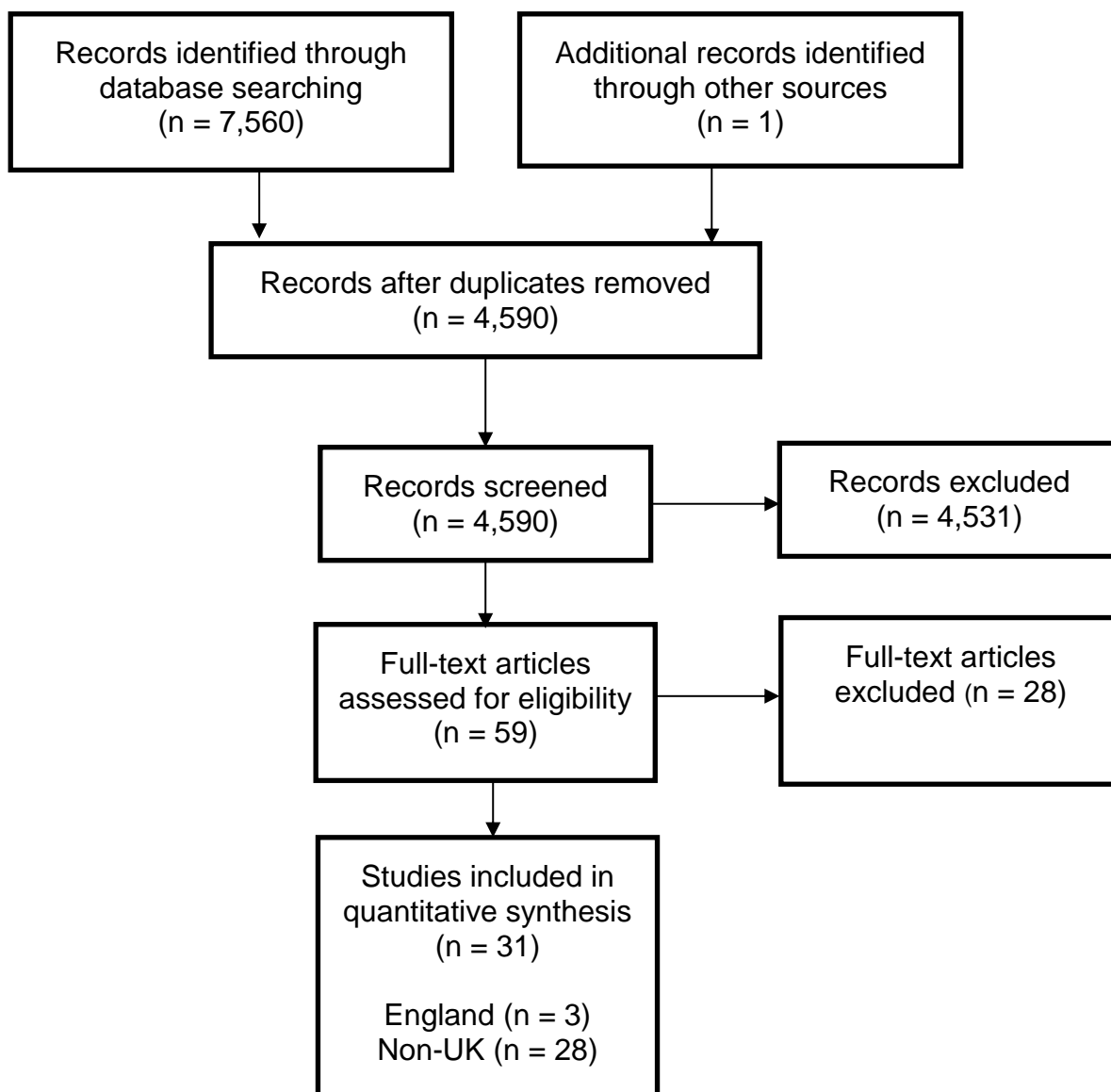
Table 16: Study characteristics − mental health conditions and vaping

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
England				
Hickling et al., (2019) [137]	England Sept 2014 to Nov 2016	Uncontrolled, single group pre-post study	*MHC patients* n=50 *Age*: 39 (SD 10.7) *Female*: 24% *Diagnosis:* Schizophrenia 54%; Schizoaffective disorder 20%; Bipolar disorder 16%; Delusional disorder 4%; Unspecified non-organic psychosis 6%	Maudsley Charity, NIHR Biomedical Research Centre, South London and Maudsley NHS Foundation Trust and King's College London
Simonavicius et al., (2017) [128]	England June 2016	Cross-sectional survey: online	*Mental health professionals* n=695 *Age:* <34=14.1%; 35-44=22.2%; 45-54=34.7%; ≥55=29.1% *Female:* 82.7% *Professional discipline*: specialist practitioner 43.2%; community practitioner 40.3%; service manager/commissioner/other 16.5%	Cancer Research UK and BUPA (a UK based private healthcare provider) Foundation
Smith et al., (2019) [138]	England March and August 2017	Focus groups (Qualitative)	*Mental health professionals* n=39 *Age*: 37.4 (SD 13.5) *Female:* 71.8% *Service type:* inpatient wards: 10%; community mental health services: 38.5%; primary care 51.3% *Professional discipline*: Psychologist/trainee/assistant/Psychological wellbeing/CBT. Therapist practitioner 51.3%; Occupational Therapist/support worker/forensic mental health practitioner/social worker 17.9%; Nurse/student nurse 15.4%; Psychiatrist 10.3%; administrator/assistant 5.1%	British Heart Foundation and Cancer Research UK

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
Outside UK				
Baltz and Lach (2019) [139]	US Oct 2017 to Mar 2018	Cross-sectional survey: in person	*MHC patients* n=110 *Mean age*: 33.1 (SD 9.4) *Female:* 43.6% *Diagnosis:* Not reported (all attended outpatient clinic for treatment for depression, anxiety, schizophrenia, bipolar disorder	Not reported
Bandiera et al., (2016) [140]	US Nov 2014 to Feb 2015	Cross-sectional survey: online	*Total sample n=* 5,438 *MHC sample* n=1,686 *Mean age:* 20.4 (SD 2.4) *Female:* 67.9% *Diagnosis*: High depressive symptom (CES-D score ≥ 10)	National Cancer Institute and the FDA Center for Tobacco Products
Bianco et al., (2019) [141]	US 2012 to 2015	Cross-sectional (as part of a smoking cessation RCT follow-up assessment)	*MHC patients* n=456 *Mean age*: 45.4 (SD 10.8) *Female:* 63.6% *Diagnosis:* Schizophrenia-spectrum disorder 25.9%; Bipolar disorder 20.6%; major depression 21.9%; other 31.6%.	Centers for Medicare & Medicaid Services
Brady et al., (2019) [142]	US Apr 2014 to Jan 2017	Repeated cross-sectional survey as part of smoking cessation study)	*MHC sample* n=1,007 *Demographics of MHC sample not reported. Demographics separated by non-users and users of vaping products* *Age:* 53 *Female:* 58.3% *Diagnosis:* Self-reported ever diagnosis of anxiety disorder, depression, bipolar disorder, schizophrenia or alcohol or drug abuse disorder	Arizona Department of Health Services, University of Arizona Cancer Center Behavioral Measurement and Interventions Shared Resource & NIH-NCI Cancer Center Support Grant
Caponnetto et al., (2013) [165]	Italy 2012 to 2013	Uncontrolled, single group pre-post study	MHC patients n=14 *Age:* 44.6 *(SD 12.5)* *Female:* 57% *Diagnosis:* 100% Schizophrenia	CTA-Villa Chiara Psychiatric Rehabilitation Clinic and Research and Smoking Prevention/Cessation Centre, University of Catania, Italy

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
Chen et al., (2017) [144]	US 2014	Cross-sectional survey: in person	*MHC patients* n= 231 *Age*: 42.8 (SD 13.5) *Female*: 59% *Diagnosis: Not reported. All attending treatment for severe mental illness*	Not reported
Chen et al., (2018) [143]	US 2013 to 2015	Longitudinal survey, computer assisted self-administered	*Total sample*: 12,383 *MHC sample*: 4,817 *Demographics for total sample (MHC sample not reported)* *Age: 18-24=42.7%; 25-34=57.5%* *Female: 49.4%* *Diagnosis:* Past month mental health symptoms	Department of Behavioral and Community Health, School of Public Health, University of Maryland College Park.
Cummins et al., (2014) [145]	US Feb to March 2012	Cross-sectional survey: online	*Total sample n=* 10 041 *MHC sample* n=1,905 *Age:* 18-29=20.1%; 30-44=26.9%; 45-59=31.2%; 60+=21.7% *Female:* 63.5% *Diagnosis:* Self-reported, anxiety, depression or other MHC	Funder: University of California, US
Hefner et al., (2016) [166]	US March to May 2015	Cross-sectional survey: in person	*Total sample n=188* *Sample with at least one MHC* n=155 *MHC patients only sample* n=51 Substance use only patients n=33 Dual diagnosis patients n=104 Dual diagnosis n=104 *Age* (total sample) 18-30=8.1%; 31-50=23.4%; 50+=68.6% *Female* (total sample) 8% *Diagnosis:* PTSD 44.1%; Bipolar disorder 24.5%; Depression 39.9%; Anxiety 35.6%; Personality disorder 11%; Schizophrenia 11.2%	Mental Illness Research Education Clinical, Centres, Department of Veterans Affairs, NIDA & NIH
King et al., (2018) [147]	US 2018	Cross-sectional survey: online	Total sample n=2,370 *MHC sample n=249* *Mean age: 21.1 (SD 0.6)*	National Cancer Institute of the National Institutes of Health & FDA Center

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
			Female: 67.5% *Diagnosis:* Past 6-month self-reported MHC. 81.5% reported 1 MHC, 17.3% reported 2 MHC, 1.2% reported 3 MHC. Past 7-day depression score (CESDISF) 11.4 (SD 7.2); Past month stress scale score (Cohen's Perceived Stress Scale) 20.6 (SD 7.5)	for Tobacco Products (CTP)
Kioi & Tabuchi (2018) [163]	Japan Jan to Feb 2015	Cross-sectional survey: online	Total sample n=4,432 *MHC sample* n=243 *MHC sample demographics not reported* *Age:* 40-69 (mean not reported) *Female:* 55.9% *Diagnosis:* not reported, other than depression among women=4.2% & among men=1.1%.	Health Labour Sciences Research Grant & the Japan Society for the Promotion of Science
Meurk et al., (2016) [158]	Australia 2014 to 2015	Mixed methods: focus groups & cross-sectional survey	*MHC patients* n=29 *Age*: median=45 *Female:* 48.3% *Diagnosis:* not reported (all attending community mental health services)	University of Queensland Health and Behavioural Sciences Faculty
Miller et al., (2017a) [149]	US March 2015	Cross-sectional survey: online	*MHC sample* n=135 *Mean age:* 30.2 (SD 8.4) *Female:* 49.6% *Diagnosis:* SPD (K6 score of ≥13)	NIDA & the Food and Drug Administration Centre for Tobacco Products
Miller et al., (2017b) [148]	US Data collection period not reported	Cross-sectional survey: in person	*MHC patients* n=60 *Mean age:* 45 (SD 14) *Female:* 33% *Diagnosis:* 100% schizophrenia or schizoaffective disorder	Not reported
Morean and L'Insalata (2017) [150]	US Autumn 2016	Cross-sectional survey: online	Total sample n=611 *MHC (Eating Disorder) only sample* n=178 *Mean age:* 33.3 (SD 8.3) *Female:* 72.5% *Diagnosis:* Anorexia 21.7%; Bulimia 22%; Binge-eating disorder 39%; EDNOS/OSFED=11%	Not reported

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
O'Brien et al., (2015) [162]	New Zealand Sept 2011 to July 2013 (original RCT)	RCT (secondary analysis)	MHC sample n=86 *Age*: 44 (SD 12) *Female*: 66% *Diagnosis*: Reported use of ≥1 medicine for mental illness; Antidepressants: 64 (74%); Antipsychotics: 24 (28%); Other psychotropics: 23 (27%)	Health Research Council NZ
Park et al., (2017) [151]	US 2014	Cross-sectional survey: face-to-face	*Total sample n*= 36,697 *MHC sample n*=5,834 *MHC sample demographics not reported* *Age (total sample):* 18-35=26.7%, 35-64=49.8%, 65+=18.8% *Female (total sample):* 51% *Diagnosis:* Past 30-day serious psychological distress (SPD) (K6 score 11-24: 2,027)	NIH/NCI & the Abu Dhabi Institute, New York University/Abu Dhabi
Pratt et al., (2016) [152]	US Oct 2013 to June 2014	Uncontrolled, single group pre-post study	*MHC patients* n=19 *Age:* 42 (SD 14.6) *Female:* 68% *Diagnosis*: Schizophrenia & schizoaffective disorder: 53%; Bipolar disorder: 47%	Geisel Scholl of Medicine, Dartmouth, New Hampshire, US
Prochaska and Grana (2014) [153]	US 2009 to 2014	Repeated cross sectional surveys (as part of smoking cessation RCT)	*MHC patients*=956 *Age:* 39 (SD 14) *Female*: 50% *Diagnosis:* Unipolar depression 27%; Bipolar depression 32%; Psychosis 27%; Other 14%. 68% also had SUD	NIMH & State of California Tobacco Related Disease Research Programme
Sharma et al., (2017)[160]	Australia April 2016	Qualitative	MHC sample n=413 *Age & gender not reported* *Diagnosis:* self-reported schizophrenia 2.1%; depression bipolar disorder 4.6%; 28.6%; anxiety 34.9%; multiple diagnoses 21.8%; other=7.9% Mental health practitioners (n=12) Friend/relative of someone with MHC (n=30)	International Postgraduate Research Scholarship & University of Queensland Centennial Scholarship & National Health and Medical Research Council
Sharma et al., (2018a) [161]	Australia	Focus groups Qualitative	*MHC patients* n=29 *Age:* 42.8 (SD 10.4)	VicHealth and Quit Victoria

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
	Time frame not reported		*Female:* 48.3% *Diagnosis*: depression 55.2%; anxiety 55.2%; bipolar 31.0%; schizophrenia 27.6%; PTSD 27.6%; ADHD 10.3%; personality disorder 6.9% and multiple diagnoses 75.9%	
Sharma et al., (2018b) [159]	Australia Time frame not reported	Cross-sectional survey: online	*Mental health professionals* n=267 *Age & gender not reported* *Professional discipline*: Medical practitioners 13.9%; nurses 22.8%; community mental health practitioners 22.8%; allied health practitioners 24.7%; others 3.4%.	New South Wales Ministry of Health
Spears et al., (2017) [154]	US Aug to Sept 2015	Cross-sectional survey: online	*Total sample* n=6,016 *MHC sample* n=1,082 *Age:* 18-44=48.5%; 45-60+=51.5% *Female:* 63.2% *Diagnosis:* Self-reported anxiety 8.6%; depression 13.4%; bipolar disorder 2.4%; schizoaffective 0.4%; schizophrenia 0.4%, mood disorder 2.3% and other 1.6%	NIH/NIDA and FDA Center for Tobacco Products
Spears et al., (2018a) [156]	US Aug to Sept 2017	Cross sectional survey: online	*Total sample* n=5,762 *MHC sample* n=1,209 *Age:* 18-29=26.4%; 30-44=22.7%; 45-59=18.3%; 60+=14.1% *Female:* 24.2% *Diagnosis:* Lifetime self-reported MHC, anxiety 11.9%; depression 13.8%; bipolar disorder 2.6%; schizoaffective 0.3%, schizophrenia 0.4%; mood disorder 1.9%; other 2%; past month SPD (K6 score ≥13) 8.2%	NIDA; FDA Center for Tobacco Products; NIH/NCCIH
Spears et al., (2018b) [155]	US Aug to Sept 2015	Cross-sectional survey: online Only the current vapers from Spears et al., (2017) study were included in this study	*Total sample* n=550 *MHC sample* n=172 *Age:* 18-29=31.1%; 30-44=35%; 45-59=23%; 60+%=10.9% *Female:* 65.8% *Diagnosis:* Bipolar disorder 6.7%; schizoaffective disorder 1%; schizophrenia	NIDA; FDA Center for Tobacco Products; NIH/NCCIH

Authors and year of publication	Country and date of data collection	Study design	Participants	Funder
			0.4%; anxiety 15.6%; depression 19.8%; other 4.1%	
Valentine et al., (2018) [157]	US Data collection period not reported	Uncontrolled, single group pre-post study	*MHC patients n*=43 *Age*: 56.9 (SD 8) *Female*: 7% *Diagnosis*: Schizophrenia: 2%; Schizoaffective disorder: 8%; Bipolar: 5%; Depression: 35% PTSD: 42%; ADHD: 5%	New England Mental Illness Research, Education and Clinical Center, US Dept of Veteran's Affairs; NIH and FDA Center for Tobacco Products
Wang et al., (2018) [107]	US 2016 to 2017	Cross-sectional survey: in person	*Total sample n*=26,742 *MHC sample* n=10,911 *MHC sample demographics not reported.* *Total sample -* *Age:* 18-24=18.3%; 25-44=22.5%; 45-64=21.3%; 65+=11% *Female:* 14.2% *Diagnosis:* 40.8% with SPD (K6 score ≥13)	CDC, FDA and the National Institutes of Health's National Cancer Institute
Wiernik et al., (2019) [164]	France January 2015 to Dec 2016	Cross-sectional survey: either pen or paper or online	*Total sample* n=35,337 *MHC sample* n=5,631 *MHC sample demographics not reported* *Age*: 45.8 (13.9) *Female:* 52% *Diagnosis:* all pts had past 7-day depressive symptoms (CES-D ≥19)	Institut National du Cancer; Institut de Recherche en Santé Publique

Center for Epidemiological Studies Depression IOWA Short Form (CESDISF); Center for Epidemiological Studies Depression (CES-D), Serious Psychological Distress (SPD); Kessler Screening Scale for Psychological Distress (K6); Eating disorder not otherwise specified (EDNOS), Other specified feeding or eating disorder (OSFED), Post-traumatic stress disorder (PTSD), Attention deficit hyperactivity disorder (ADHD); Cognitive behavioural therapy (CBT); National Institute for Health Research (NIHR); National Institute on Drug Abuse – US (NIDA).

RQ1: Prevalence of vaping among people with a mental health condition

England

No prevalence studies were identified. We are therefore unable to report vaping prevalence in people with MHC in England or the rest of the UK.

Outside the UK

Seventeen studies were identified that provided information about vaping prevalence [107, 139-142, 144-149, 151, 153, 154, 156, 163, 164] (Table 17). One study was conducted in France [164], one in Japan [163] and the rest in the US [107, 139-142, 144-149, 151, 153, 154, 156]. Five studies recruited participants from a nationally representative sample of the population in the US and were rated as low risk of bias [107, 145, 151, 154, 156]. Six studies recruited participants from representative state-wide or regional populations and were rated as low to moderate risk [140, 142, 147, 149, 163, 164]. Six studies recruited participants from clinical settings and were rated as moderate to high risk of bias [139, 141, 144, 146, 148, 153]. Sample sizes for MHC participants ranged from 1,082 to 10,911 for the nationally representative survey studies; 135 to 5,631 for state-wide or regional populations and 60 to 956 for studies that included participants from clinical samples.

Prevalence of ever vaping

Twelve studies assessed participants who had ever tried vaping (Table 17) (appendix B includes a description of how each study defined ever vaping). Across the nationally representative studies, overall, irrespective of smoking status, prevalence of ever vaping among participants with MHC ranged from 14.8% [145] to 40.1% [156]. Combining the results from 2 studies that reported ever vaping by specific diagnosis using the same data source [154, 156], ever vaping was most common in participants with schizoaffective disorder (43.9%), followed by bipolar disorder (42%) and least common in participants with schizophrenia (25%). Across the representative state-wide or regional populations, prevalence ranged from 5.3% [163] to 66.9%[149]. Only one study [139] from a clinical setting reported ever vaping prevalence (56.8%). Overall, ever vaping prevalence among non-MHC participants ranged from 6.6% [145] to 18.4% [156] for nationally representative samples.

Prevalence differed according to smoking status. Nine of the 12 studies reported ever vaping prevalence according to participants' smoking status.

Across the nationally representative studies, ever vaping among current smokers, ranged from 40.3% [145] to 75.3% [156]. Among former smokers, ever vaping prevalence ranged from 7.1% [151] to 31% [145]. Among never smokers the proportion who have ever tried vaping ranged from 0.5% [145] to 14.1% [156]. In the representative state-wide or regional population studies, 2 studies [149, 164] reported ever vaping among current smokers (66.9% and 41.9% respectively). Among former smokers, 10.1% had ever vaped and 0.5% of never smokers had ever vaped [164]. Ever vaping among current smokers was 11% for participants recruited from clinical settings.

Prevalence of current vaping

Twelve studies assessed participants current vaping status (Table 17) (appendix B includes a description of how each study defined current vaping, these included any use in the past 30 days, or use daily, on some days or rarely in participants who reported a history of ever vaping). Across the nationally representative studies, overall, irrespective of participants' smoking status, prevalence of current vaping among participants with MHC ranged from 3.1% [145] to 19.7% [156]. Combining the results from 2 studies that assessed current vaping by specific diagnosis [154, 156], current vaping was most common in participants with schizoaffective disorder (26.3%), followed by bipolar disorder (23.3%) and least common in participants with schizophrenia (10%), similar to the findings for ever vaping. Across the representative state-wide or regional population studies, prevalence of current vaping ranged from 1.4% for males and 0.3% for females [163] to 20.9% [140]. One study in a clinical setting [146] reported overall prevalence of 45.1%. Overall current vaping prevalence among non-MHC participants ranged from 1.1% [145] to 7.5% [156] for nationally representative studies and 5% [147] to 15.6% [140] in representative state-wide or regional populations studies.

Prevalence differed according to smoking status. Six of the 12 studies reported current vaping according to smoking status. Across the nationally representative studies, vaping among current smokers (ie. concurrent use) ranged from 8.6% [145] to 40.8% [156]. Current vaping among former smokers ranged from 6.7% [154] to 9.7% [156]. Among never smokers, current vaping ranged from 0.2% [145] to 6.7% [156]. Of the representative, state-wide or regional population samples, one study [164] reported vaping among current smokers (16.2%). Prevalence was 5.7% among former smokers, and 0.2% in never smokers [164]. Current vaping among current smokers was not reported separately for participants recruited from clinical samples.

Prevalence of smoking

For the studies included in the review that included both MHC and non-MHC participants, smoking prevalence among MHC participants from nationally representative samples ranged from 25.3% [154] [156] to 35.2% [107], compared with 12.1% [154] [156] to 13.2% [107] for non-MHC participants. Smoking prevalence among MHC participants from representative state-wide or regional samples ranged from 20.4% [147] to 26.4% [140] compared with 14.5% [147] to 18.8% [140]) in non-MHC participants.

Table 17: Vaping prevalence in people with a mental health condition

Authors	Data Source	Vaping prevalence in MHC and non-MHC	Vaping prevalence by smoking status	Risk of bias[1]
Outside UK				
Nationally representative				
Cummins et al., (2014) [145]	General population survey (KnowledgePanel)	*MHC* Ever=14.8% Current=3.1% *Non-MHC* Ever=6.6% Current=1.1%	*Current smokers (27.8%)* Ever vaper=40.3% Current vaper=8.6% *Long term former smokers (16.4%)* Ever vaper=3.3% Current vaper=0.3% *Recent former smokers (26.0%)* Ever vaper=31% Current vaper=7.5% *Never smokers (13.4%)* Ever vaper=0.5% Current vaper=0.2%	Low risk (2/10)
Park et al., (2017) [151]	National Centre for Health Statistics, CDC	Not reported	*Current smokers (not reported)* Ever vaper: not reported Current vaper=12.9% *Former smoker (not reported)* Ever vaper=7.1% Current vaper: not reported *Never smoker (not reported)* Ever vaper=6.8% Current vaper: not reported	Low risk (2/10)
Spears et al., (2017) [154]	2015 Tobacco Products and Risk Perceptions Survey	MHC Ever=24.4% Current=11.4% Non-MHC Ever=15.5% Current=6.6%	*Current smokers (23.2%)* Ever vaper=57.1% Current vaper=33.2% *Former smoker (29.5%)* Ever vaper=24.8% Current vaper=6.7% *Never smoker (47.3%)*	Low risk (3/10)

Authors	Data Source	Vaping prevalence in MHC and non-MHC	Vaping prevalence by smoking status	Risk of bias[1]
			Ever vaper=7.7% Current vaper=3.5%	
Spears et al., (2018a) [156]	2017 Tobacco Products and Risk Perceptions Survey	MHC Ever=34.2% Current=16.3% (every day, some days, rarely) Current=3.3% (daily) Non-MHC Ever=16.7% Current=6.5% (every day, some days, rarely) Current=1.6% (daily) SPD (K6>13) Ever=40.1% Current=19.7% (every day, some days, rarely) Current=4.7% (daily) No SPD Ever=18.4% Current=7.5% (every day, some days, rarely) Current=1.7% (daily)	*Current smokers (25.3%)* Ever vaper=75.3% Current vaper=40.8% *Former smoker (30.4%)* Ever vaper=29.1% Current vaper=9.7% *Never smoker (44.2%)* Ever vaper=14.1% Current vaper=6.7%	Low risk (3/10)
Wang et al., (2018) [107]	2017 National Health Interview Survey	MHC Ever: Not assessed Current=7.9% Non-MHC Ever: not assessed Current=2.6%	*Current smoker (35.2%)* Ever & current vaper not assessed	Low risk (2/10)
Representative state-wide or regional populations				
Bandiera et al., (2016) [140]	State-wide convenience sample of college students across 24 colleges and universities	MHC Ever: Not assessed Current=20.9% Non-MHC Ever: Not assessed Current=15.6%	*Current smokers (26.4%)* Ever & current vaper not assessed	Moderate risk (4/10)

Authors	Data Source	Vaping prevalence in MHC and non-MHC	Vaping prevalence by smoking status	Risk of bias[1]
Brady et al., (2019) [142]	ASHLine (state based Quitline) callers who received tobacco cessation assistance	MHC Ever: 20.6% Current: not reported Non-MHC Ever: 16.5% Current: not reported	*Not reported*	Moderate risk (4/10)
King et al., (2018) [147]	Undergraduate students from 9 public and 2 private colleges	MHC Ever: not assessed Current= 8% Non-MHC Ever: not assessed Current=5%	*Current smokers (20.4%)* Ever & current vaper not reported	Moderate risk (5/10)
Kioi and Tabuchi (2018) [163]	Survey panel including respondents only aged 40 to 69 years	Males Ever=9.9% Current=1.4% Females Ever=5.3% Current=0.3% Non-MHC not reported	*Current smokers: males (36.7%)* Ever and currently vape not reported *Former smokers: males (23.1%)* Ever and current vaper not reported *Current smokers: females (17.5%)* Ever and current vaper not assessed *Former smokers: females (15.6%)* Ever and currently vape not assessed	Moderate risk (4/10)
Miller et al., (2017a) [149]	Smokers recruited through Amazon.com MTurk survey panel	Not applicable	*Current smoker (100%)* Ever vaped=66.9% Current vaper: not assessed	Moderate risk (6/10)
Wiernik et al. 2019 [164]	Survey of cohort of adults covered by national health insurance (Constances cohort)	MHC Ever=15% Current=6.3%	*Current smokers (not reported)* Ever vaper=41.9% Current vaper=16.2% *Former smokers (not reported)* Ever vaper=10.1% Current vaper= 5.7% *Never smokers (not reported)* Ever vaper=0.5% Currently vape=0.2%	Low risk (3/10)
Clinical (non-representative)				
Baltz & Lach (2019) [139]	Convenience sample from an outpatient mental health clinic	Ever=56.8% Current: Not applicable	*Current smoker (53.7%)* Ever and current vaper not assessed *Ever smokers (82.7%)* Ever and current vaper not assessed	Moderate risk (6/10)

Authors	Data Source	Vaping prevalence in MHC and non-MHC	Vaping prevalence by smoking status	Risk of bias[1]
Bianco et al., (2019) [141]	Patients with SMI receiving mental health treatment in 10 New Hampshire CMHCs who smoked and who enrolled in a smoking cessation RCT (vaping products not part of interventions)	Not applicable	*Current smokers (86.6%)* Ever and current vaper not assessed *Former smokers (13.4%)* Ever and current vaper not assessed *Current* and *former smokers (100%)* Ever vaped=42.1% Current vaper: not assessed	Low risk (3/10)
Chen et al., (2017) [144]	Patients with SMI attending four CMHCs in Missouri, US	Ever= not reported Current=22%	*Current smokers (57%)* Ever and current vaper not assessed *Former smokers (21%)* Ever and current vaper not assessed *Never smokers (22%)* Ever and current vaper not assessed	High risk (7/10)
Hefner et al., (2016) [146]	Veterans attending mental health and substance use clinics who smoked or recently quit with VA Connecticut Healthcare system	MHC only Ever-not assessed Current=45.1% SUD=12.1% Dual Diagnosis=29.8%	*Not reported*	Moderate risk (6/10)
Miller et al., (2017b) [148]	Inpatient and outpatients in one adult mental health service, with a diagnosis of schizophrenia or schizoaffective who were current or former smokers	Not applicable	*Current smoker (70%)* Ever and current vaper not reported *Former smoker (30%)* Ever and vaper not reported *Current* and *former smokers (100%)* Ever vaper: 37% Current vaper: 7%	Moderate risk (5/10)
Prochaska & Grana (2014) [153]	Patients with SMI who smoked and who enrolled in a smoking cessation RCT (vaping products not part of interventions)	Not applicable	*Current smokers (100%)* Ever vaper (recent use among current and former smokers) =11%	Moderate risk (4/10)

* Weighted. [1] Hoy et al. [51]; SMI – Serious mental illness.

RQ2: Characteristics of vaping among people with a mental health condition

We identified 4 cross-sectional studies all from the US [139, 143, 146, 150] that included information on characteristics of use and we have summarised them here (Table 18). Information on characteristics of use in 5 other studies (all intervention studies) are reported separately in Table 19 below, with regards to the types of devices, nicotine strengths and flavours used. We separated these because participants from cross-sectional studies may have used vaping products 'naturalistically' and had a choice over the products they used, whereas participants in intervention studies were generally not given a choice and were instructed what to use and how to use them.

Study characteristics are described in Table 16 and findings about device used, frequency of use, nicotine strength and flavours used are in Table 18. Information was not reported consistently, therefore it is difficult to say if there are common patterns of use. Device type and frequency was reported in only one study [146]. Most participants (48%) were using 'rechargeable or refillable' devices and the majority (67%) vaped 1 to 10 days in the past month; 27.6% reported vaping 21 to 30 days in the past month. Nicotine strength used was reported in 3 studies. The most common strength used by participants in the study by Baltz and Lach [139] was 1-5mg/ml (20.2% of participants) and 6-12mg/ml (by 19% of participants in the study by Hefner et al. [146]. Morean and L'Insalata (137) reported the mean strength among their participants (with an eating disorder) was 9.5mg/ml. Flavours were reported in only one study [143]: in a nationally representative longitudinal survey of the participants with a past-month MHC, 3.1% were using vaping products with tobacco or menthol flavours and 7.6% were using vaping products with non-tobacco and non-menthol flavours (eg. fruit or candy) at a later assessment [143]. This was compared to 2% of participants without past-month MHC symptoms who were using vaping products with tobacco or menthol flavours and 4.3% using vaping products with non-tobacco and non-menthol flavours during a later assessment.

Table 18: Characteristics of vaping in people with a mental health condition

Authors	Vaping status	Device used	Frequency of use	Nicotine strength	Flavours used	Quality assessment
Baltz and Lach (2019) [139]	Clients attending a CMHC who had ever tried vaping (n=62)	Not reported	Not reported	Did not use any nicotine =7.3%; 1-5mg/ml= 20.2%; 6-10mg/ml =16.5%; 11-5mg/ml =9.2%; 16-20mg/ml =4.6% Unsure=15.6%	Not reported	Poor quality
Chen et al., (2018) [143]	Young adults aged 18-34 with past month MHC (n=481)7 from a longitudinal cohort survey (PATH)	Not reported	Not reported	Not reported	MHC: Used tobacco or menthol flavour=3.1%; Used non-tobacco and non-menthol= 7.6% (eg. presumed fruit or candy). Non-MHC: Tobacco or menthol = 2.0% Non-tobacco or menthol flavour =4.3%.	Good quality
Hefner et al., (2016) [146]	Veterans attending a treatment clinic for MHC and/or substance use disorder who currently vaped (n=58)	Disposable (31.0%), 'Rechargeable or refillable' (48%) (details missing for 11%)	Vaped 1 to 10 days out of the past month = 67.2%; Vaped 21–30 days in past month =27.6% Vaped 11 to 20 days in past month= 5.2%	6-12 mg/ml=19.0%; 18-24 mg/ml=17.2%; Unsure= 17.2% (details missing for 27 participants).	Not reported	Poor quality
Morean and L'Insalata 2017 [150]	People with (n=169) and without (n=393) an eating disorder who were current vapers	Not reported	Not reported	Mean nicotine concentration among vapers with an eating disorder =9.5mg/ml without an eating disorder r=7.9mg/ml	Not reported	Fair quality

RQ3: The effects of vaping on smoking cessation or reduction among people with a mental health condition

We identified 5 studies that reported on the effect of vaping for smoking reduction or cessation (Table 19). Study characteristics are described in Table 16.

England

One study was conducted in England [137]. This was a single group pre-post study. Fifty participants with severe mental illness were recruited from community mental health teams in London and followed up for 24 weeks. Participants smoked an average of 18 cigarettes per day (CPD) and had smoked for an average of 22 years.

Outside the UK

One study was conducted in Italy [165], one in New Zealand [162] and 2 in the US [152, 157]. All were single group pre-post studies, with the exception of O'Brien et al. [162] which was a secondary analysis of participants with MHC included in the first published RCT of vaping products for stopping smoking [167]. The original study by Bullen et al. [167] has been reported in detail in our previous reports [3, 4]. Sample sizes ranged from 14 [165] to 86 [162]. The longest follow-up was 12 months [165] and the shortest was 4 weeks [152, 157].

Two studies recruited individuals with severe mental illness (schizophrenia, schizoaffective or bipolar disorder) [152, 165]; one study included individuals with either a common mental disorder (eg. depression or post-traumatic stress disorder) or a severe mental illness and some of whom also had a substance use disorder [157]. O'Brien et al. [162] did not purposefully recruit people with MHC or collect data on diagnosis; they categorised participants as 'likely to have' a mental illness if they reported using ≥1 psychotropic medicines at baseline. One study recruited individuals from an inpatient setting [165], the other 2 studies recruited from community/outpatient settings. Participants were either moderately or heavily dependent on cigarettes and 2 studies reported participants had smoked for more than 20 years [137, 152, 165]. Four studies recruited participants not intending to quit [137, 152, 157, 165]. Risk of bias and quality assessment ratings are included in tables and in appendix C. The study designs and lack of control or comparator groups increase the risk of bias in the single group pre-post studies.

Description of interventions

Hickling et al. [137], supplied participants with a first generation disposable prefilled, rechargeable vaping product with 45mg/ml of nicotine for 6 weeks.

In the study by O'Brien et al. [162], participants were randomised to receive either a 16mg/ml nicotine vaping product, a non-nicotine vaping product, or a 21mg nicotine patch from one week before until 12 weeks after the participants nominated quit date. This was the only study to also provide behavioural support alongside the supply of vaping products (low intensity behavioural support over the telephone). The other studies supplied vaping products and e-liquids with instructions on use for 4 to 6 weeks. Valentine et al. [157] gave participants a choice of 3 flavours (menthol and 2 types of tobacco flavour) and nicotine strengths (12mg/ml or 24mg/ml) to use with a second-generation tank device. Participants in the other studies were provided with a first-generation disposable device with 7.4mg/ml nicotine [165], and a second-generation tank device [152].

Outcomes (cessation and reduction)

A description of the cessation and reduction outcomes are described in Table 19. By the end of the supply period, CO validated quit rates in the studies that recruited participants not intending to quit ranged from 7% [137, 157] to 14% [165]. Longer term quit rates were 1% at 6 months for Hickling et al. [137] and 14% at 12 months in the Caponnetto et al. [165] study. In the study by O'Brien et al. [162] (where study participants were motivated to quit) 5% of participants with MHC randomised to the 16mg/ml vaping product quit compared with 7% without MHC; for those randomised to the placebo product, no participants with MHC quit, compared with 5% of non-MHC participants. The differences between those with and without MHC in the vaping product arms in this trial was not significant. For those randomised to the 21mg nicotine patch arm, 14% of MHC participants quit compared with 5% of non-MHC participants which was a significant difference (p=0.003).

In the single group pre-post studies, there was a significant reduction in cigarettes per day, CO levels and Fagerstrom Test for Nicotine Dependence (FTND) scores in both the short and long term (with the exception of Valentine et al. [157] who observed a non-significant decrease in CO levels at 4-week follow-up).

Participants in the Valentine et al., study [157] reduced their CPD by an average of 7.6 between baseline and 4-week follow-up, though CO levels did not decline significantly (baseline =9.3ppm versus 4-week FU=8.5ppm). Participants in the Pratt et al., study [152] significantly reduced their cigarettes smoked per week, from 204 at baseline to 75 at the end of the 4-week supply period. Twenty-five percent of participants in Hickling et al. [137] and 58.3% of participants in Caponnetto et al. [165] reduced their CPD by

≥50% at 6- and 12-month follow-up. In the study by O'Brien et al. [162] the mean percentage reduction in CPD was 49% for participants with MHC randomised to the 16mg/ml vaping product compared with 51% for participants without MHC. For those randomised to the placebo product, there was a 31% reduction for participants with MHC compared with a 47% reduction for non-MHC participants. For those randomised to the 21mg nicotine patch arm, there was a 29% reduction in CPD in MHC participants compared with a 41% reduction in non-MHC participants. These differences were not significant.

Table 19: Detail of vaping interventions, smoking characteristics at baseline and outcomes

Author	Vaping product details	Supply and support given	Smoking characteristics at baseline	Cessation outcomes	Reduction outcomes (for non-quitters)	Quality assessment[1]
England						
Hickling et al., (2019) [137]	Disposable NJOY 45mg/mL	6-weeks supply participants were encouraged to replace smoking.6-week supply was followed by a 4-week post-intervention follow-up, participants were encouraged to continue to use e-cigarettes, but purchase their own	CPD: 17.9 (SD 11.9) CO: 26ppm Years of smoking 22.3 (SD 11.1) Not intending to quit smoking	CO validated: End of 6-week supply: 7% (4/50) had quit. Week 10: 5% were non-daily smokers Week 24: 1 completely quit, 1 became a non-daily smoker	% who achieved ≥50% reduction in CPD: End of 6-week supply=37% (p<0.001) 10 weeks after baseline=26% (p<0.001) 24 weeks after baseline =25% (p<0.001)	12/16
Non-UK						
Caponnetto et al., (2013) [165]	Rechargeable, prefilled disposable device (Categoria): 3.7 V-90 mAh lithium-ion battery 7.4 mg/ml tobacco	4-weeks supply Instructed how to use them and advised to use up to a maximum of 4 cartridges per day, ad libitum	CPD: 30* (IQR 20,35) CO: 29ppm* (IQR=23.5, 35.2) FTND: 7* (IQR=5,10) Pack years: 28.8 (SD 12.9) Not intending to quit smoking	14% (2/14) (self-reported quitters. CO levels reduced from 24 ppm to 2ppm at 12-month FU	% who achieved ≥50% reduction in CPD: 12 months=58.3% (p<0.01)	10/16
O'Brien et al., (2015) [162]	Rechargeable, prefilled disposable device (Elusion) 16mg/ml vaping product, or 0mg/ml vaping product, or NRT patch 21mg	12-weeks supply after patient's nominated quit date. Low intensity behavioural support over the telephone E-cigarette, spare battery and charger, and cartridges (with labels masked to nicotine content), plus simple instructions to use them as desired	CPD: 19.4 FTND: 6.3 Motivated to quit smoking	CO validated 16 mg vaping product: 5% (2/39) quit 0mg vaping product: 0% (0/12) 21mg nicotine patch: 14% (5/35) quit at 6-month FU	Mean reduction in CPD from baseline to 6 months: 16 mg/ml vaping product: 9.9 (SD 7) 0mg/ml vaping product: 4.7 (SD 3.5) 21mg nicotine patch: 5.7 (SD 6.3)	23/24

Author	Vaping product details	Supply and support given	Smoking characteristics at baseline	Cessation outcomes	Reduction outcomes (for non-quitters)	Quality assessment[1]
		were delivered couriered to participants				
Pratt et al., (2018) [152]	Prefilled, rechargeable tank device 2nd generation NJOY Nicotine strength not reported	4-weeks supply. Participants returned for 4 weekly study visits for assessment and to return used cartridges and receive a new supply of e-cigarettes	CPW: 191.9 (SD 159.3) CO: 27.4ppm FTND: 5.50 (SD 1.79) Years of regular smoking: 23.6 (SD 15.1) History of failed treatment-facilitated quit attempts and no current desire to quit	10.5% (2/19) self-reported quitters. CO levels 3ppm for one person and 14ppm for the other at end of supply period	CPW: Decrease between baseline=204.5 and end of supply period =75 (p=0.005) CO level: Decrease between baseline=26.94ppm and end of supply period=16 ppm (p=0.004) FTND: Decrease between baseline=5.5) and end of supply period=3.86 (p=0.002)	6/16
Valentine et al., (2018) [157]	Rechargeable, refillable device (eVic Supreme, Joyetech). 6.5 ml tank) and a C3 triple coil atomizer head with a total resistance of 1.8 ohms. Menthol (27mg/ml) Tobacco Burley and Slim) 12-24mg/ml 50/50 PG/VG *(Propylene Glycol/ Vegetable Glycerine)*	4-week supply Participants sampled a choice of six e-liquids, attended an 'adaptation session' and taught how to use device, supplied with 2 bottles of 5ml e-liquid of their choice in first week (more bottles dispensed as needed for heavier smokers or after requests to sample other e-liquids)	CPD: 16.6 (SD 9.4) CO: 9.3ppm (7.1) FTND: 4.9 (SD 2.1) Not intending to quit smoking	7% (3/43) self-reported quitters CO levels reduced from 9.3ppm to 1.8ppm 4-week FU	CPD: Decrease between baseline=16.6 and 4-week FU=9 (p<0.001) Decrease in CO levels between baseline =9.3ppm and end of supply =7ppm (p<0.01) and at 4-week FU=8.5ppm (ns). Decrease in FTND from baseline=4.9 to 4-week FU=3.5 (p<0.003)	6/16

Carbon monoxide (CO). Cigarettes per day (CPD). Cigarettes per week (CPW). Follow-up (FU). Fagerstrom Test for Nicotine Dependence (FTND), Interquartile range (IQR). [1] [136]

Acceptability of the vaping products used in intervention studies

Hickling et al. [137] reported common reasons for stopping vaping products after the free distribution period ended; most commonly, financial reasons (30.4%) and not getting around to (17.4%) or not wanting to (10.9%) purchase one. Only a minority stopped because of dislike for the taste (4.4%), stigma (2.2%), or not wanting to become addicted to vaping (2.2%). At week 6, 41.3% of participants said they would like to use vaping products more and cigarettes less, and 82.6% perceived vaping products to be less harmful than tobacco cigarettes.

Pratt et al. [152] reported participants believed vaping was healthier than smoking, helped them feel more accepted by non-smokers and eliminated the offensive odour of tobacco cigarettes. However, some participants reported not feeling the same 'hit' they received with tobacco cigarettes and tended to revert to using cigarettes when experiencing emotional distress, when they forgot to charge the device or when they forgot to carry the device with them.

Valentine et al. [157] reported that among participants who completed the vaping products supply phase and their one-month follow-up assessment (n= 30), 43% stated they preferred vaping to smoking (an increase from 17% at baseline). In contrast, a comparable proportion at baseline (27%) and follow-up (30%) reported a preference for combustible tobacco; 38% purchased a vaping product after the free supply finished.

O'Brien et al. [162] assessed acceptability of vaping products after 6 months and found that 83% of MHC participants randomised to the 16mg/ml vaping product, and 80% of those randomised to the 0mg/ml product compared with 37% who used the NRT patch said they would recommend their respective products to a friend. These did not significantly differ compared to the non-MHC group (85%, 89% and 63% respectively). O'Brien et al. [162] also reported how many participants stopped using vaping products or NRT because they did not like them: 29% of MHC participants stopped the 16mg/ml vaping product; 22% stopped the 0mg/ml vaping product and 41% stopped the nicotine patch compared with 23%, 21% and 41% of non-MHC participants (not significantly different).

Study protocols

The database search also identified 2 study protocols of RCTs to evaluate a vaping intervention among smokers with severe mental illness. Caponnetto et al. [168] proposed to conduct an RCT with 153 smokers with schizophrenia who were not willing to stop smoking and randomise them to a 24mg nicotine vaping product, a 0mg product or a nicotine free inhalator and follow up participants for up to 12 months. This study, as described, did not start. Instead, Caponnetto et al. conducted a 3-month pilot study with 40 smokers with schizophrenia to test a 59mg/ml nicotine vaping product. Two of the report authors (LBa and DR) are also

involved in this study. The findings from the study (currently being prepared for submission to a journal) will inform a new protocol for an RCT (personal communication from Caponnetto). In the second published protocol, Bullen et al. [169] proposed to conduct a RCT with 338 smokers attending community mental health/addiction services in New Zealand and motivated to quit. It was proposed that after 2 weeks of varenicline and behavioural support, participants who had not reduced their smoking would be randomised to either a further 10 weeks of varenicline and behavioural support or a further 10 weeks of varenicline plus a 18mg/ml nicotine vaping product and behavioural support. Reduction and cessation rates would be assessed after 24 weeks.

Professor Chris Bullen the lead author was contacted for more information and kindly provided the following update*: "This trial was stopped a year after recruitment by agreement between the research team and funder because of very slow rates of recruitment, despite best efforts. The numbers of participants randomised were far below those required to lead to robust conclusions about the effectiveness of interventions. The recruitment difficulties have been explored in a review commissioned by the funder [Health Research Council, NZ] that focuses on the specific challenges of conducting smoking cessation trials within mental health and addiction services."

RQs 4 and 5: Physical and mental health adverse effects and benefits of vaping among people with a mental health condition

We took information from the intervention studies rather than cross-sectional surveys to answer this question, to enhance confidence that vaping preceded an adverse effect or benefit [54].

Adverse effects and events

All 5 intervention studies assessed adverse effects associated with vaping. We have used the primary author's terminology when describing adverse effects. Hickling et al. [137] assessed adverse effects at baseline, weeks 2, 6, 10 and 24 and serious adverse events at baseline, weekly for 10 weeks and at 24 weeks follow up using a visual analogue scale and patient clinical records. During their intervention period, they reported that the most commonly reported adverse effects were throat irritation (28.3%), dry cough (19.6%) and dry mouth (15.2%). There were no significant changes in the reporting of adverse effects between baseline and week 6 (all p > 0.05). They also reported 5 serious adverse events that occurred during the study. All were psychiatric hospitalisations, 4 were due to a worsening of psychotic symptoms and one was due to a worsening of depressive symptoms. All were considered unrelated to the study intervention. There was no significant increase or decrease in cough, phlegm production, breathlessness, tightness in the chest or wheezing from baseline to week 6 (all p > 0.05).

Furthermore, there were no significant changes in respiratory peak-flow rates from baseline to week 6, week 6 to week 10 or week 10 to week 24. There were no significant differences in respiratory symptoms or peak-flow rate between smoking reducers and non-reducers.

Caponnetto et al. [165] assessed adverse events on 5 occasions over 12 months using participants study diaries. Adverse events were known common side effects of vaping and tobacco withdrawal symptoms; serious adverse events were defined as an event requiring an unscheduled visit to the family doctors or hospitalisation. The most frequently reported adverse effects in the whole sample were nausea (14.4%), throat irritation (14.4%), headache (14.4%), and dry cough (28.6%), most of which disappeared by 12 weeks with none reported at 24 weeks follow-up. Capponnetto et al., [165] was the only study to additionally report adverse effects in participants who had quit smoking, those who concurrently smoked and vaped and those who continued to exclusively smoke.

Participants in the Pratt et al. [152] study were asked whether they had experienced common side effects associated with vaping products at each weekly visit. Self-reported side effects were described as generally mild and short-lived. About 58% of participants reported any side effects, including dry or sore throat, mild nausea and cough. Among those who reported side effects, 55% experienced one symptom for one week, 37% experienced more than one symptom for 1 to 2 weeks, and only one person had a symptom for ≥2 weeks (a mild cough for 4 weeks). Valentine et al. [157] reported that none of their participants experienced any serious adverse events (no further information given).

O'Brien et al. [162] defined adverse events as related or unrelated to the intervention, and serious or non-serious. These were categorised by a member of the study team masked to the intervention product. They reported that 44 adverse events occurred among 35 MHC participants compared with 248 events among 194 non-MHC participants. This difference was not statistically significant. A single psychiatric adverse event occurred in the MHC group − a depressive episode that was not considered study-related. The only study-related adverse event in the MHC group was a sore throat in a person allocated a 16mg/ml vaping product. No serious study-related adverse events were noted in any group.

Two studies reported on the potential association between vaping and mental health symptoms. Hickling et al. [137] reported no significant changes in positive, negative or general symptoms of schizophrenia or depressive symptoms at any time point, in the whole sample or in the participants who reduced their smoking compared with non-reducers (assessed using the Positive and Negative Syndrome Scale [170] and Calgary Depression Scale [171]). Similarly, Caponnetto et al. [165] reported no significant changes in positive and negative symptoms of schizophrenia after smoking reduction or cessation following vaping (assessed using the Scale for the Assessment of Positive Symptoms [172] and the Scale for the Assessment of Negative Symptoms [173]. Neither O'Brien et al. [162], Pratt et

al. [152] or Valentine et al. [157] reported on changes in mental health symptoms, using a validated rating scale.

Benefits

In addition to findings regarding the acceptability/appeal of vaping products reported above, 2 studies reported on other benefits. Pratt et al. [152] asked participants to rate enjoyment and satisfaction of vaping compared with smoking on a 5-point Likert-type scale. Ratings of enjoyment (mean ratings of 4-4.1) and satisfaction (mean ratings of 3.6-4) were consistently high over the 4-week study period. In response to open-ended questions about the subjective experience of using vaping products, participants commented that they perceived vaping products to be healthier, helped them feel more accepted by non-smokers and eliminated the offensive odour of combusted tobacco. They also reported coughing less, sleeping better and feeling less addicted to nicotine.

Valentine et al. [157] reported that participants spent less money on cigarettes over time with substantial savings from baseline to follow-up (about $50 at baseline compared with about $18 at the end of the free supply and about $30 at 4-week follow-up).

RQ6: Barriers and facilitators of vaping among people with mental health conditions

Sixteen studies are included in this section [128, 137-139, 145, 146, 148-150, 152, 155, 156, 158-161]; their characteristics are described in Table 16 and quality assessment scores are in appendices D and E.

Reasons for use

Reasons for ever or current vaping were reported in 6 studies [139, 145, 146, 150, 155, 160]. Five of these studies provided participants with options to choose from [139, 145, 146, 150, 155]; though measurement was not consistent across studies. Sharma et al. [160] conducted a thematic analysis of reasons for use from Reddit online posts about vaping and mental health.

Nationally representative surveys
Among the nationally representative survey participants (Table 16 and Table 17), Cummins et al. [145] asked about reasons for vaping among ever or current vapers. Among people with MHC, the most common reason stated was "just because" (69.6%) compared to 67.4% without MHC. The next most common reason was to try to quit smoking (MHC=59.6% versus non-MHC=52.9%). Around half of vapers with MHC (54.6%) reported that vaping products were safer than cigarettes and easy to use (50.4%) compared with 48.5% and 42.5% of non-MHC

participants respectively. Lastly 36.7% of vapers with MHC reported they were cheaper than cigarettes as a reason for use, compared with 27.9% of those in the non-MHC group. Spears et al. [155] reported mean ratings of current vapers with and without MHC (on a 7-point scale). The most popular reason among vapers with a MHC irrespective of smoking status, was because they were "less harmful to those around me than cigarettes" (mean 4.20), followed by "less harmful to me than cigarettes" (mean 4.16), and "they could help me reduce the number of cigarettes I smoke" (mean 4.02). There were no significant differences overall (among all participants irrespective of their smoking status) about reasons for vaping between participants with and without MHC and when compared to current smokers. However former smokers with MHC who vaped compared with former smokers without MHC rated the following reasons as more important: using them in places where regular smoking is not allowed; less harmful to self than regular cigarettes; less harmful to others than regular cigarettes; quitting smoking or reducing smoking and appealing flavours.

Representative state-wide and regional populations and clinical samples
Hefner et al. [146] reported that among people with MHC and/or substance use disorder who vaped, the most frequent reasons for use were the ability to use them in non-smoking areas (64.8%), saving money (53.7%), and the perception that vapour is less harmful to others (40.7%). Baltz and Lach [139] reported that among people with MHC who had ever tried vaping, the most frequent reasons were because vaping products were perceived to be less harmful than tobacco cigarettes (41.3%) and to quit smoking (41.3%). Other reasons included because they were more socially acceptable (21.1%), because of the variety of flavours available (20.2%), because they were cheaper than tobacco cigarettes (13.8%), with the least common reason being because of recommendations from a healthcare provider (7.3%).

Morean and L'Insalata [150] reported that vapers with an eating disorder compared to vapers without a history of an eating disorder, were significantly more likely to report that they vaped for weight loss (OR 4.06); because of the availability of sweet flavours (OR 1.79); because it was easy to hide/conceal from others (OR 2.75) and because it was difficult to detect indoors (OR 1.63). Themes identified by Sharma et al. [160] in an analysis of online posts (Reddit) about vaping and mental health included that participants were motivated to vape to self-medicate, quit smoking, for freedom and control, as a hobby, for social connectedness and because of encouragement from caregivers.

Participants who completed the vaping intervention in the Valentine et al. [157] study (n=30) were asked to indicate from a fixed list, why they vaped or may vape in the future. The most popular reason was "to save money" (70%), followed by "to reduce the amount I smoke" (60%) and because "vapour is less harmful to others" (56.7%).

Perceptions about vaping among people with mental health conditions

In addition to reasons for trying vaping or current use of vaping products, 10 studies also described attitudes and perceptions towards vaping from the perspective of people with MHC [137, 139, 148-150, 155, 156, 158, 160, 161]. Study characteristics are reported in Table 16 and all are from the US except the studies by Sharma et al. [160, 161] and Meurk et al. [158] from Australia. Perceptions are synthesised into themes.

Perceived effect on reducing the urge to smoke and for quitting smoking

Five studies included perceptions about quitting smoking with vaping products. The majority of participants (67.0%) in the study by Baltz and Lach [139] agreed that vaping products can help people quit smoking, 47.6% agreed that flavourings can help people quit and 42.9% agreed that they can reduce the urge to use tobacco. Potential benefits of using vaping products identified by Miller et al. [148] included reducing cravings to smoke (23%), satisfying the desire to smoke (27%), cutting down on smoking (33%) and helping to quit smoking (30%). In contrast, Miller et al. [148] also reported that 15% believed they did not release enough nicotine, 13% felt that they did not satisfy their desire to smoke and 10% felt that the taste was unpleasant. Sharma et al. [160] reported participants found vaping useful for quitting smoking, though there was also some concern of still being addicted to nicotine.

In a separate study by Sharma et al. [161], some participants reported that following encouragement from friends and family members to use vaping devices, they switched and found them useful to reduce their smoking. Meurk et al. [158] reported that one of the perceived strengths of using vaping devices was that they can mimic the perceived positive elements of smoking, provide a similar psychological and sensory experience of cigarette smoking and can be used as a harm reduction strategy. However, some participants expressed concerns about replacing the habit of smoking with another habit of using vaping devices, as they wanted to transition away from using any nicotine product.

Perceived effect on mental health

We reported above on studies that evaluated changes in mental health symptoms before and after a vaping intervention for smoking cessation, measured using validated rating scales. Five other studies reported subjective effects without using a validated scale to measure mental health [148-150, 155, 160]. Morean & L'Insalata [150] reported that those with an eating disorder compared to those without one were significantly more likely to agree that vaping helps deal with anxiety. Miller et al. [149] reported those with and without MHC were equally likely

to agree that vaping products can help when feeling tense or nervous. Spears et al. [155] reported that vaping was perceived to improve concentration in never smokers, but not in current smokers. Miller et al. [148] reported that 72% of their participants felt regular use of vaping products made them feel less depressed and 38% felt that vaping made them feel less paranoid. Sharma et al. [160] reported positive perceptions among Reddit online posts including an improvement in concentration and general mental health. As these data are from cross-sectional studies, it is difficult to establish if the perceived positive effects are directly related to vaping.

Perceived effect on physical health

In addition to the physical effects reported in the intervention studies above, 3 non-intervention studies reported on physical effects. Baltz and Lach [139] reported that 44.3% of their participants said they could breathe and exercise better when using a vaping product compared to tobacco cigarettes. In the study by Miller et al. [148] which included patients with schizophrenia, a small proportion of ever vapers reported side effects, the most common were cough (15%), headache (10%) and dizziness (10%). In Miller et al's [149] study, participants with and without MHC were less concerned about negative physical effects and future health concerns when using vaping products compared to tobacco cigarettes. Meurk et al. [158] reported that some participants expressed concerns about the long-term health impact of using vaping devices, with one participant reporting a perceived worsening of their asthma after using vaping devices.

Perceived effect on weight control

Two studies reported participants with MHC compared to those without MHC [149, 150] were significantly more likely to believe that vaping products can help control weight and appetite.

Perceptions about social acceptance

In the study by Baltz and Lach [139], a majority of respondents (60.4%) agreed with the statement that vaping was socially acceptable. In Miller et al. [148], 32% of participants felt that being able to vape in public places where tobacco cigarettes are not allowed was helpful. Sharma et al. [160] reported that participants believed vaping could facilitate social connectedness. Meurk et al. [158] reported that participants felt that one of the perceived strengths of vaping was the lack of a negative effect on bystanders, particularly because of the absence of the smell of smoke.

Legal context

Two studies were conducted in Australia, where nicotine-containing vaping devices are prohibited. In both of these studies [158, 161] participants reported that the legal framework was a barrier to using vaping products, with participants in Meurk et al. [158] expressing concerns that the police could misidentify certain types of devices as drug paraphernalia.

Harm perceptions

Four studies reported on subjective perceptions of harm from vaping compared with tobacco cigarettes [137, 139, 148, 155]. Among people with MHC, more than 50% of participants in each study reported that vaping products were less harmful than tobacco cigarettes. For example, in the studies by Spears et al. 2018b [155], 60.5% of those with MHC perceived they were less harmful and this perception was similar for participants without MHC. Vaping devices were perceived to be less harmful than tobacco cigarettes in 82.6% of participants in the study by Hickling et al. [137] and 56% of participants in the study by Baltz and Lach [139]. However, in the study by Miller et al. [148] only 34% perceived vaping devices as less harmful than tobacco cigarettes; 17% believed they were more harmful; 17% believed they were equally harmful and 32% did not know.

Perceptions of health professionals about vaping among people with a mental health condition

We identified one study conducted in England that elicited mental health practitioners' views about vaping products as a tobacco harm reduction strategy. Smith et al. [138] conducted a thematic analysis of focus groups with 39 mental health practitioners. The majority worked in community and primary care mental health settings in London; 10% were psychiatrists and 12% nurses, the remainder were mostly psychologists. Although there was some support for the use of vaping products in mental health settings, particularly when patients choose them as a quitting aid or to help stay smokefree during a period of inpatient care, this group of health professionals seemed misinformed and risk averse about the use of vaping products in mental health settings.

Two surveys of health professionals' views about supporting people with MHC to quit smoking, one in England and one in Australia, included specific questions about vaping products. Simonavicius et al. [128] surveyed practitioners working in English stop smoking services about their knowledge, confidence and training needs related to mental health and smoking. Among the 665 who responded, practitioners had limited knowledge about the effect of smoking and quitting on smokers' mental health, though were moderately confident about supporting smokers to quit with a vaping product. In a survey of Australian mental health

practitioners, Sharma et al. [159] reported that around a third of the 267 practitioners surveyed offered comprehensive support to smokers with MHC. Practitioners were mostly ambivalent about the role of vaping products for harm reduction or quitting. However, those who were current smokers were more likely to agree that switching completely to vaping as a long-term substitute for tobacco cigarettes may reduce smoking-related harm. Health practitioners who had received smoking cessation training, compared to practitioners who had not received training, were more likely to recommend that smokers who struggled to quit should switch to vaping.

Ongoing research in England

As indicated in a previous PHE report [4], the STS was enhanced to include questions on mental health in 2016 and 2017 (and these will be included through SPECTRUM funding [174] from 2020 moving forwards). Some of the authors, led by Leonie Brose, have submitted a paper on vaping (and smoking) among people with and without MHC from the STS, which is currently under review. Additionally, we had previously mentioned [4], that the 2014 Adult Psychiatric Morbidity Survey had included question on vaping, but these data have not yet been published. This means that the evidence on vaping among people with MHC in England will be available in the future.

Conclusions

Summary of findings

- in our systematic review, we did not identify any vaping prevalence studies from England, so we are unable to report on rates of vaping among people with mental health conditions in England, or in other parts of the UK
- we identified 17 studies that reported vaping prevalence in people with mental health conditions outside the UK
- definitions of current vaping varied across studies, for example, any use in the past 30 days or use every day, on some days or rarely. So, the findings and any comparisons between studies should be treated with caution
- overall, rates of current vaping ranged from 3% to 20% among people with mental health conditions in nationally representative population samples. Rates ranged from 0.3% to 21% in representative state-wide or regional survey samples and from 7% to 45% among participants recruited from clinical settings. These high rates of vaping likely reflect the high prevalence of smoking among people with mental health conditions
- among nationally representative and state-wide or regional samples, current smokers had the highest rates of ever vaping (up to 75%) and current vaping rates (up to 41%)
- there are currently no published randomised controlled trials (RCTs) evaluating vaping products for smoking cessation or reduction for smokers with mental health conditions. We identified 4 single group 'pre-post studies', a type of study

looking at participants before and after an intervention, and a secondary data analysis of RCT data that included a sample of people with a mental health condition. In 4 of the studies, participants were not motivated to quit. Complete abstinence from smoking was achieved by 7% to 14% of participants between 4 weeks and 12-month follow-up across the studies. Study participants who vaped significantly reduced their cigarette intake

- the sparse literature that exists on health professionals' knowledge and attitudes about vaping suggests that many are ambivalent about the role and use of vaping products among smokers with mental health conditions. It also suggests there are unmet training needs

Implications

- one of the actions in the government's Tobacco Control Plan for England was to explore how more reliable data could be collected to better inform tobacco control measures to support people with mental health conditions. Ongoing studies on vaping (and smoking) in these people in England will help fill some evidence gaps. But more nationally representative data are still needed, particularly for people with severe mental health conditions
- high rates of smoking and vaping together suggests that smokers with mental health conditions should be advised and supported to quit smoking completely, as soon as they feel able to do so
- more research is needed on vaping among people with mental health conditions and its efficacy and safety for quitting smoking
- there are signs that health professionals need more tailored training on the use of vaping products among people with mental health conditions
- resources on vaping among people in mental health settings are available from the Mental Health and Smoking Partnership in England. Since vaping is allowed in most mental health trusts in England, the experience of using vaping products over time in these settings should be explored, including their effect on completely switching from smoking to vaping

Chapter 6: Systematic review of vaping in pregnancy and postpartum

Introduction

This chapter reports results from a systematic review of the current evidence about vaping in pregnancy and postpartum. It includes a brief overview of smoking and nicotine use in pregnancy; a summary of the available evidence on the prevalence of vaping in pregnancy, on the maternal and fetal health implications of vaping; on perceptions of vaping and barriers and facilitators to vaping among pregnant women and relevant healthcare providers. This chapter then summarises the implications for pregnant women, policy-makers and healthcare providers according to the current evidence base. Please note the terminology section in Chapter 1 for definitions of vaping used in this report.

Smoking in pregnancy

In 2018 to 2019, 11% of pregnant women in England smoked at the time of delivery, but this ranged from 2% in some affluent areas of London to 26% in Blackpool, an area that experiences high levels of deprivation [175]. One of the ambitions of the Tobacco Control Plan for England that relates to pregnancy is to reduce smoking at the time of delivery to 6% or less by the end of 2022 [34].

Smoking when pregnant increases the risk of adverse outcomes including low birth weight, miscarriage, neo-natal and sudden infant death, perinatal morbidity and mortality, premature delivery and stillbirth [176, 177]. There are also associations between smoking in pregnancy and infant behavioural outcomes [178, 179]. Exposure to second-hand smoke (from the expectant father for example) is also associated with lower birth weight [180]. Many of the adverse effects of smoking are improved when smokers quit smoking [181]. Additionally, current socio-economic inequalities such as higher rates of infant deaths and stillbirths in more deprived groups could be reduced by lower levels of smoking in pregnancy [182].

While many smokers quit when pregnant, it has been challenging to find effective interventions to support those who find it difficult to stop. A Cochrane review concluded that counselling, financial incentives and providing feedback increased cessation but that outcomes were affected by the characteristics and context of interventions. The same review also highlighted the lack of effective interventions available to help prevent post-partum relapse to smoking among women who had quit while pregnant [181].

Cessation outcomes arising from the provision of pharmacological support for smoking cessation in pregnancy are limited; guidance for both bupropion and varenicline cautions against prescribing in pregnancy [183]. Nicotine replacement therapy has shown little efficacy in controlled trials; however, trials mostly used a single NRT product and none used a combination of a patch with a faster-acting type of NRT, that has been shown to be more effective in clinical practice [184]. Efficacy is further limited by low adherence [185] and increased metabolism of nicotine during pregnancy [186].

Nicotine use in pregnancy

There is limited evidence on the effects of nicotine in pregnancy separate from smoking.

A 2018 report by the National Academy of Sciences, Engineering and Medicine (NASEM) summarised several animal studies which reported adverse effects of in utero nicotine on lung development and postnatal lung function and behaviour [187]. However, none of the studies assessed dose-response and the models used for exposure may not replicate the human exposure [187].

Importantly, pregnant women who smoke already consume nicotine alongside the other carcinogenic and harmful constituents of tobacco smoke. Pregnant women who switch to NRT reduce their nicotine exposure [188]. National guidance in the UK includes that nicotine in the form of NRT can be prescribed during pregnancy [189].

The Cochrane review on pharmacological interventions for smoking cessation in pregnancy reported that there was insufficient evidence to conclude if NRT had either positive or negative impacts on rates of miscarriage, stillbirth, preterm birth, low birthweight, admissions of babies to neonatal intensive care or neonatal deaths or whether this affected mean birthweights among infants [185]. However, in one trial in which infants were followed until 2 years of age, those born to women who had been randomised to NRT (compared with placebo) were more likely to have healthy development [190].

Similarly, the 2018 report by NASEM concluded that there was no available evidence whether or not vaping affects pregnancy outcomes and that there was insufficient evidence whether or not maternal vaping affects fetal development [187].

Objectives

Our objectives addressed the following review questions (RQ):

1. What is the prevalence of vaping during pregnancy and post-partum?
2. Among people who vape during pregnancy, what patterns of use are identified; eg. frequency of use, vaping products, strength and flavour of e-liquid.
3. Among people who vape during pregnancy, what reasons for use and perceptions are identified?
4. What are the effects of vaping on smoking cessation or reduction during pregnancy and post-partum?
5. Which health outcomes have been reported in studies of vaping in pregnancy and what findings have been reported for these outcomes?
6. What are the reported barriers to, and facilitators of, vaping in pregnancy?

Methods

Protocol and registration

This systematic review followed PRISMA guidelines and the protocol was registered in advance with the international prospective register of systematic reviews (PROSPERO), registration number-CRD42019136150, and is available at www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019136150.

Eligibility criteria

Types of participants: Studies were included where participants were people who had used vaping products during pregnancy, babies born to people who had used vaping products during pregnancy, or health professionals who had worked with people who had vaped (or smoked) during pregnancy.

Types of interventions: Any type of vaping product used by people who are pregnant.

Types of comparator or controls: For review questions 1 (prevalence), 2 (patterns of use) and 6 (barriers and facilitators) no control group was required. For all other review questions, studies were not limited to specific comparator groups. Instead, studies were assessed to see if the comparator groups used are appropriate for our review questions and are reported here where present.

Types of studies: Randomised, quasi-randomised, non-randomised studies; single group pre-post-test study designs; cohort, case control, longitudinal and cross-sectional studies; mixed methods and qualitative studies were included.

We excluded case studies from the literature because of the low quality of evidence they present and the inability to establish causality. The search strategy used was not optimised to identify all relevant case studies therefore those that were identified (n=2) were excluded.

Information sources and search methods

The databases searched for this review were CINAHL, Embase, Medline, PubMed and Maternity and Infant Care Database (MIDIRS). No start date was added to the search; the cut-off date for inclusion was 16 September 2019. Articles were included where they were peer-reviewed and reported data on vaping in pregnancy. Articles that reported data from animal studies, in vitro studies or studies published in a language other than English, French, German or Italian, were excluded. Titles and abstracts were screened by one author with a subsection screened by a second author. Interrater agreement between authors was measured using Cohen's kappa [50]. Two authors completed full-text screening with differences discussed and resolved with a third.

Data collection process and data items

Data were extracted from the included studies by 2 authors using the data extraction protocol described in the PROSPERO [49] registrations documents and included here in appendices.

Risk of bias in included studies

Included studies were assessed for potential bias or quality. Hoy and colleagues' method was used to assess the risk of bias in prevalence studies [51], the Newcastle-Ottawa Scale was used for cohort studies [52] and COREQ [53] was used to assess the quality of qualitative studies.

Results

The database search on 16 September 2019 produced 1,099 articles, which was reduced to 750 after removing duplicates. After screening, 112 articles were identified, of which 27 were included after accessing the full-text and assessing against the eligibility criteria (Figure 43). The final Cohen's kappa coefficient to measure agreement between reviewers during the screening process was 0.66, which indicates 'moderate' agreement [50].

Figure 43: Prisma flow diagram

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┌─────────────────────────┐              ┌─────────────────────────┐
│ Records identified      │              │ Additional records      │
│ through database        │              │ identified through      │
│ searching               │              │ other sources           │
│ (n= 1,099)              │              │ (n= 0)                  │
└───────────┬─────────────┘              └───────────┬─────────────┘
            │                                        │
            ▼                                        ▼
        ┌───────────────────────────────────────────────────┐
        │ Records after duplicates removed                  │
        │ (n= 750)                                          │
        └─────────────────────┬─────────────────────────────┘
                              │
                              ▼
        ┌──────────────────────┐        ┌──────────────────────┐
        │ Records screened     │───────▶│ Records excluded     │
        │ (n= 750)             │        │ (n= 638)             │
        └──────────┬───────────┘        └──────────────────────┘
                   │
                   ▼
        ┌──────────────────────┐        ┌──────────────────────┐
        │ Full text articles   │───────▶│ Full text articles   │
        │ assessed for         │        │ excluded             │
        │ eligibility          │        │ (n= 85)              │
        │ (n= 112)             │        │                      │
        └──────────┬───────────┘        └──────────────────────┘
                   │
                   ▼
        ┌──────────────────────┐
        │ Studies included in  │
        │ qualitative synthesis│
        │ (n=27)               │
        │                      │
        │ UK (n=6)             │
        │ Non-UK (n=21)        │
        └──────────────────────┘
```
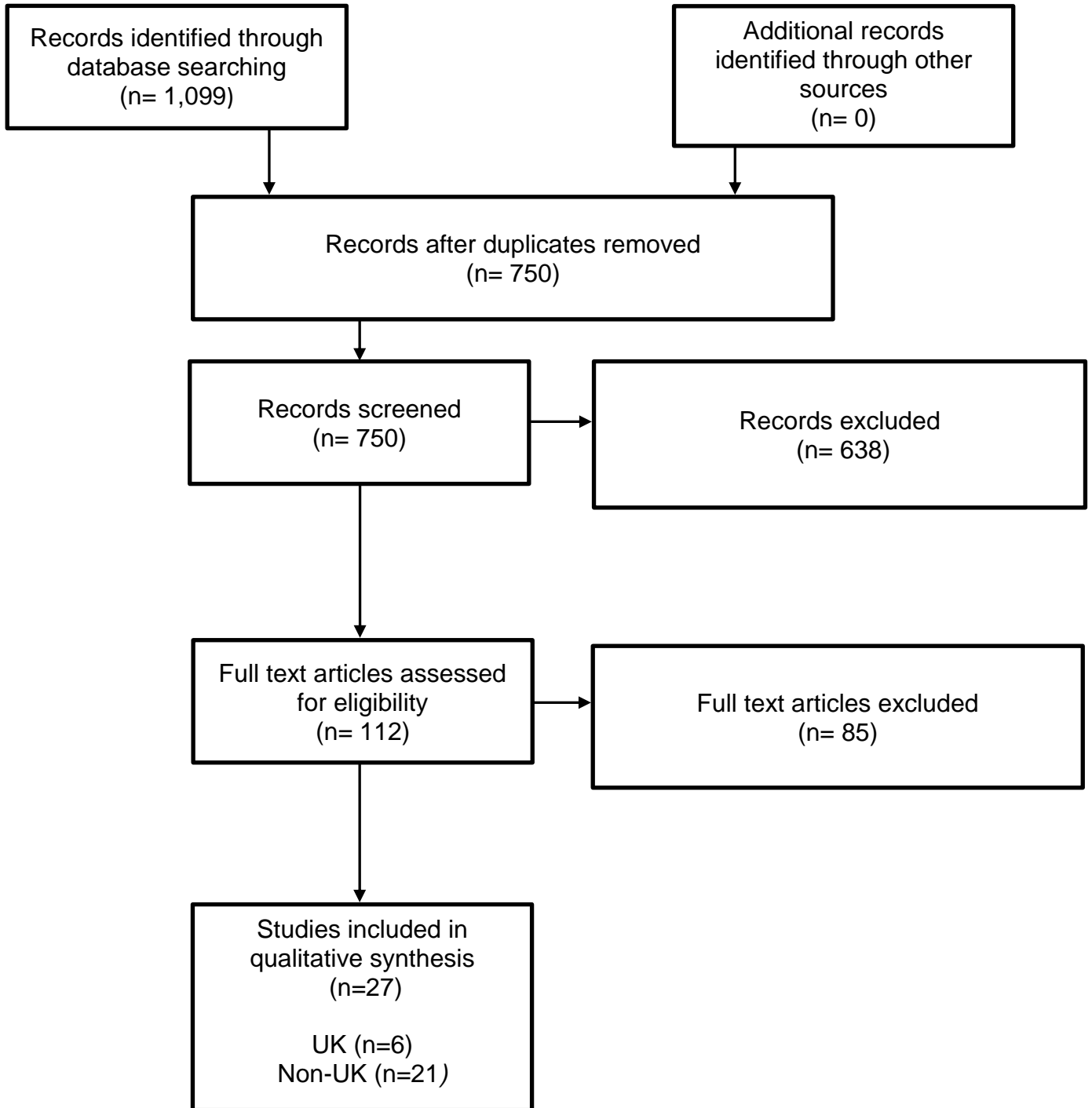
Description of included studies

This section describes the included studies, first from the UK and subsequently from other countries. Subsequent sections take the same format (UK studies first, followed by studies from other countries).

UK

Design

Six of the included studies were from the UK [191-196] (Table 20). Three of these were qualitative studies based on interviews with pregnant women [191, 192, 194]. One study reported data from cross-sectional surveys of pregnant women and of people working in smoking cessation services [196] and one collected cross-sectional survey and interview data from smoking cessation service managers [193]. One study collected data from online discussion forums [195]. There were no nationally representative studies.

Participants

Four studies recruited women who were pregnant and who smoked, or who recently smoked [191, 192, 194, 196], 2 recruited health professionals [193, 196], and one analysed online discussion forums related to pregnancy and did not report the smoking or vaping status of participants [195]; this study is also likely to have included participants from other countries.

Outside the UK

Almost all the studies outside of the UK were from the US [197-214] where 18 studies were located (Table 20). One study was based in Australia [215] and 2 were based on analyses of online forums not restricted to a specific country [216, 217].

Design

Nine of the studies from outside of the UK reported cross-sectional survey data [197, 198, 202, 206, 208-210, 213, 214], one longitudinal survey data [207]. Four of those surveys were representative of the population of the US or specific US states [206-209]. Three further studies used data from randomised controlled trials, one was a secondary analysis of baseline data from a trial of NRT for smoking cessation in pregnancy [211], one was a secondary analysis of data from a trial of a text messaging programme for smoking cessation in pregnancy [200] and the third a stepped-wedge cluster randomised pilot study of an educational intervention for smoking cessation [215]. Three studies were based on qualitative interview or focus group data [203-205], a further 2 conducted content analyses of online forum posts [216, 217]. One article reported quantitative data from interviews [212]. Two

articles reported data from a single cohort study that monitored women during and after pregnancy [199, 201].

Participants

Six studies included women who were pregnant or had recently been pregnant regardless of their smoking status [198, 205, 206, 208, 210, 213], 6 studies included smokers or recent former smokers who were pregnant, recently pregnant or planning a pregnancy [197, 200, 203, 204, 211, 214], 2 used data from representative surveys that included information on smoking, vaping and pregnancy [207, 209], one purposively recruited an equal number of pregnant smokers and non-smokers [212]. Two articles used data from a single study that recruited a cohort of pregnant women and tried to recruit equal numbers of smokers, vapers and non-smokers [199, 201]. Two studies included health professionals [202, 215]. The 2 studies of online forums analysed publicly available online discussions about pregnancy but did not confirm pregnancy or smoking status of people posting on those websites [216, 217].

Risk of bias and quality

Risk of bias and quality ratings for each study varied considerably and are included in the tables reporting on vaping prevalence, characteristics of use, perceptions, smoking behaviour outcomes and pregnancy outcomes.

Table 20: Study descriptions

Author and year	Country and year of data collection	Study design	Participants	Funder
UK studies				
Bowker et al. 2016 [191]	UK 2014	Cross-sectional interview	14 pregnant women attending stop smoking services who were prescribed NRT but not used as recommended Mean (SD) age in years: 28 (4.6) Mean (SD) weeks pregnant 14 (3.6)	National Institute for Health Research; University of Nottingham
Bowker et al. 2018 [192]	UK 2015 to 2016	Cross-sectional telephone interview	15 pregnant, 15 post-partum women Age range: 21 to 38 years First trimester: 3; second trimester: 7; third: 5; 0-3 months post-partum: 6; 4-6 months post-partum: 9 Smoker: 16; Recent former smoker: 14	Cancer Research UK
Cooper et al. 2019 [193]	UK 2015	Cross-sectional survey and interview	Survey: 72 stop smoking managers responsible for supporting pregnant women Interview: 15 of the 72 stop smoking managers No information on demographics	No specific grant from any funding agency in the public, not-for-profit, or commercial sector
Johnson et al. 2019 [194]	UK Not reported	Qualitative study using a descriptive phenomenological approach	5 women who had smoked when pregnant, within the last year Age range: 18 to 20 years	No specific grant from any funding agency in the public, not-for-profit, or commercial sector
Johnston et al.2019 [195]	UK-based forums and others Not reported	An 'infodemiological' study analysing the content of online discussion forums	People posting on 2 UK based online parenting forums with more than 1,000 members 10 discussion threads on vaping and breastfeeding No information on participants reported	National Institute for Health Research School for Primary Care Research
Mann and Faflik 2018 [196]	UK 2016	Cross-sectional surveys	36 smoking cessation services 29 pregnant women attending a smoking cessation service Mean (SD) age in years: 28.3 (5.7) Mean (SD) weeks pregnant: 18.4 (7.2) Smoker: 15; Recent former smoker: 14	Unfunded exploratory pilot work
Non-UK studies				
Ashford et al. 2016 [197]	US Not reported	Cross-sectional survey	100 pregnant women and 94 non-pregnant women who used tobacco [note: authors include vaping products in this definition] in the past 12 months. Mean (SD) age in years for all 194 participants: 29.6 (6.7) Among pregnant women: Current smoker: 57%; recent former smoker: 23%, never smoker: 10% [note: 10% missing to a total of 100%, not reported] Among non-pregnant women: Current smoker: 93.6%; recent former smoker: 5.3%, never smoker: 1.1%	University of Kentucky

Author and year	Country and year of data collection	Study design	Participants	Funder
Bar-Zeev et al. 2019 [215]	Australia 2016 to 2017	Stepped-wedge cluster randomised pilot study testing an educational intervention to improve smoking cessation care knowledge, attitudes and practices	50 individual health care providers (17 general practitioners, 17 nurses or midwives, 10 Aboriginal Health Workers, 6 other) consulting with pregnant women Recruited from 6 services Female: 86% Mean age in years (range): 43.8 (18-64) Current smoker: 10%; Former smoker: 34%; Never-smoker: 56%	New South Wales Ministry of Health; Hunter Cancer Research Alliance
Bhandari et al. 2018 [198]	US 2015	Cross-sectional survey	382 pregnant women Age in years (n=376): 18-20: 16.8%; 21-24: 27.9%; 25-29: 30.0%; 30-34: 15.2%; 35-45: 10.1% Gestational age (n=373): First trimester: 11.0%; Second trimester: 26.3%; Third trimester: 55.5%; Postpartum: 7.2% Current smoker: 26.5%; Former smoker: 35.0%; Nonsmoker: 38.5% (of n=377)	Not reported
Cardenas et al. 2019 [199]	US 2015 to 2017	Cohort study of pregnant women	248 pregnant women (a subgroup of whom were included in the study by Clemens and colleagues) [201] Age in years: 18-22: 37.9%; 23-27: 30.6%; 28 and over: 31.5% Weeks pregnant: <20: 33.9%; 20 and over: 65.3%; Missing: 0.8% Current smoker: 31.0%	Arkansas Department of Health; University of Arkansas for Medical Sciences
Chiang et al. 2019 [200]	US 2015 to 2016	Secondary data analysis of a randomised controlled trial of a text-messaging intervention for smoking cessation with measures at baseline and after one month	428 pregnant women who smoked Mean (SD) age in years: 26.4 (5.8) Mean (SD) weeks pregnant: 18.1 (7.8)	National Institute on Drug Abuse of the National Institutes of Health; George Washington University
Clemens et al. 2019 [201]	US 2015 to 2016	Biomarker analysis of hair samples from a cohort study of pregnant women	A subset of 76 women from the group of 248 described by Cardenas and colleagues [199] Current smoker: 50%; former smoker: 17.1%; never smoker: 32.9% (self-reported)	National Institutes of Health Clinical and Translational Science Award; Arkansas Department of Health; Arkansas Bioscience Institute; Envoys, an advocacy group of the University of Arkansas for Medical Sciences Cancer Institute Foundation
England et al. 2014 [202]	US 2012	Cross-sectional survey	252 obstetricians-gynaecologists Female: 55.6% Current smoker: 2.4%; Former smoker: 15.5%; Never smoker: 78.2; Missing: 3.9%	Maternal and Child Health Research Program, Health Resources and Services Administration, U.S. Department of Health and Human Services

Author and year	Country and year of data collection	Study design	Participants	Funder
England et al. 2016 [203]	US 2013	Focus groups	102 women Age range: 18 to 40 Smokers planning to become pregnant: 42%; pregnant smokers: 31%; pregnant recent former smokers: 26%.	Food and Drug Administration
Fallin et al. 2016 [204]	US Not reported	Qualitative focus groups	8 pregnant and 4 newly postpartum women who smoked or used vaping products in the 3 months before or during pregnancy No further information on participants provided	Not reported
Kahr et al. 2015 [205]	US Not reported	Qualitative focus groups	87 pregnant women No information on age, smoking status or pregnancy provided	National Institute of Health; DFG (German Research Foundation); Baylor College of Medicine
Kapaya et al. 2019 [206]	US 2015	Cross-sectional survey, random sample of births	3,277 women with a recent live-birth in Texas and Oklahoma Smoking: In past 2 years: 18.5%; in 3 months before pregnancy: 16.4%; in last trimester: 6.1%; 2 to 6 months after delivery: 10.3% No further information provided	Not reported
Kurti et al. 2017 [208]	US 2013 to 2014	Cross-sectional survey	388 pregnant women Age in years: 18 to 24: 35.9%; 25 to 34: 53.2%; 35 to 54: 10.9% smoking prevalence 13.8% Mean weeks pregnant: 20.9 Current smoker: 13.8%; Former smoker: 42.8%; Never smoker: 43.3%;	National Institute on Drug Abuse; Food and Drug Administration; National Cancer Institute; National Institute on General Medical Sciences Abuse; National Institute of Child Health and Human Development; Centers for Disease Control and Prevention
Kurti et al. 2018 [207]	US 2013 to 2015	Longitudinal survey	7,841 women who responded to both waves. Of those, 332 were pregnant at wave 2. Characteristics reported are for wave 1 (when none were pregnant). For n=332 at wave 1: Age in years: 18 to 24: 32.7%; 25 to 34: 59.7%; 35 to 54: 7.6% Cigarettes: Established use: 19.2%, experimental use: 4.0% E-cigarettes: Established use: 2.8%, experimental use: 2.4% Hookah: Established use: 2.7%, experimental use: 4.5% Cigar: Established use: 2.9%, experimental use: 3.4%	National Institute on Drug Abuse; Food and Drug Administration; National Cancer Institute; National Institute on General Medical Sciences Abuse; National Institute of Child Health and Human Development; Centers for Disease Control and Prevention
Liu et al. 2019 [209]	US 2014 to 2017	Cross-sectional survey	27,920 women, of whom 1,071 were pregnant Age range: 18 to 44 years (among all 27,920 women) Current smoker: pregnant women: 8.0%; non-pregnant women: 14.3%	Not reported
Mark et al. 2015 [210]	US 2014	Cross-sectional survey	316 pregnant women, Mean (SD) age in years: 25.6 (5.5) Mean (SD weeks pregnant: 28.3 (8.3) Current smoker: 15.0%; Ever smoker: 43%	Not reported

Author and year	Country and year of data collection	Study design	Participants	Funder
Oncken et al. 2017 [211]	US 2012 to 2016	Cross-sectional secondary data analysis of a randomised controlled trial of NRT for smoking cessation in pregnancy	103 pregnant women who smoked Mean (SD) age in years: 27.7 (6.0) Mean (SD weeks pregnant: 21 (1) Ever cigarette smoker: 74%; During pregnancy: cigarettes: 50%; hookah: 11%; cigar: 11%; marijuana: 46%	National Institutes of Health; Pfizer pharmaceuticals; University of Connecticut
Schilling et al. 2019 [216]	Not reported Not reported	A 'netnographic' analysis of German speaking online forums discussing vaping in pregnancy	People posting on online forums discussing vaping in pregnancy, 25 threads with 1,552 posts were included. No information on participants reported	No funding reported
Stroud et al. 2019 [212]	US Not reported	Interview study (quantitative)	100 pregnant women, 50 smoked during pregnancy, 50 did not Mean (SD) age in years: 26 (4) Mean (SD weeks pregnant: 28.3 (8.3)	National Institute of Drug Abuse of the National Institutes of Health; Food and Drug Administration
Wagner et al. 2017 [213]	US 2015	Cross-sectional survey	445 pregnant women Mean (SD) age in years: 27.6 (5.3) Mean (SD weeks pregnant: 17.3 (9.8) Current smoker: 14.2%	National Cancer Institute; Food and Drug Administration
Wedel et al. 2018 [214]	US Not reported	Cross-sectional survey	85 pregnant women who smoked (past 30-day cigarette use) Mean (SD) age in years: 29 (5.3)	Oklahoma Tobacco Settlement Endowment Trust; National Institutes of Health
Wigginton et al. 2017 [217]	Not reported 2015	Content analysis of online forums	13 online forum discussion threads on safety of vaping No information on participants reported	Not reported

Abbreviations: NRT: nicotine replacement therapy; RCT: randomised controlled trial.

RQ1: What is the prevalence of vaping during pregnancy and post-partum?

UK

None of the included studies from the UK were nationally representative, so no data on prevalence of vaping among pregnant women in England or the UK were available.

Outside the UK

Although most non-UK studies reported the prevalence of vaping in their samples, for reporting prevalence, we report only data from those that were representative of a country, state or surveyed a clinic population. Seven studies were included in this analysis [198, 206, 208-211, 213, 214] (Table 21). Three used information that was representative for the population in the US or individual states, and were rated of low to moderate risk of bias, thus presenting the most informative data on prevalence [206, 208, 209]. Four surveys recruited from one or 2 clinic sites [198, 210, 211, 214] and were rated as having low to moderate risk of bias.

Studies assessing prevalence on a population level [206, 208, 209] reported current vaping among pregnant women between 3.6% [209] and 7.0% [206] and between 29% [208] and 39% [209] among participants who smoked or had recently smoked (Table 21) [208, 209]. Liu and colleagues [209] reported vaping prevalence between pregnant (3.6%) and non-pregnant (3.3%) women to be very similar (p=0.92 for difference) while smoking prevalence was lower in pregnant (8.0%) than non-pregnant (14.3%) women (p=0.01 for difference). All 3 surveys included a preamble to explain that questions are about nicotine, thus reducing the risk of respondents reporting vaping of other substances.

Two surveys of clinic patients reported current vaping for 5.9% and 11.9%, the third clinic survey did not report current use overall but reported 0.6% current daily use (Table 21).

Questions used as reported in the publications are included in the appendix.

Table 21: Vaping prevalence

Paper ID	Data source	Vaping prevalence	Risk of bias[1] (Hoy)
Population surveys (all US)			
Kapaya et al. 2019 [206]	Pregnancy Risk Assessment Monitoring System (PRAMS)	Vaping prevalence in peripartum period, defined as 3 months before pregnancy to 6 months after delivery: Overall: 7.0%; among those who smoked in past 2 years: 25.1%; among non-smokers: 2.9% Broken down by timing: Vaping prevalence in 3 months before pregnancy: Overall: 10.4%; among those who smoked in past 2 years: 29.8%, among non-smokers: 6.0% Vaping prevalence during last pregnancy trimester: Overall: 1.4%; among those who smoked in past 2 years: 5.1%; among non-smokers: 0.5% 2-6 months after delivery: 2.1%; among those who smoked in past 2 years: 8.6%; among non-smokers: 0.7%	Moderate risk (4/10)
Kurti et al., 2017 [208]	National survey, Population Assessment of Tobacco and Health (PATH)	Current vaping in pregnancy: Overall: 4.9%; among current smokers: 28.5%; among former smokers: 2.3%; among never smokers: 0 Former vaping in pregnancy: Overall: 18.4%; among current smokers: 44.5; among former smokers: 28.0%; among never smokers: 0.6%	Moderate risk (5/10)
Liu et al. 2019 [209]	National survey, National Health Interview Survey (NHIS)	Current vaping in pregnancy: Overall: 3.6%; among current smokers: 38.9%; among former smokers: 1.3%; among never smokers: 0.3% Vaping prevalence among non-pregnant women: 3.3% overall, 13.5% among current smokers, 8.8% among former smokers, 0.7% among never smokers	Low risk (3/10)
Clinic surveys (all US)			
Bhandari et al. 2018 [198]	Cross-sectional survey of pregnant women presenting to a single clinic (convenience sample)	Current vaping: 11.9% Former vaping: 19.1% Among current vapers, 67.4% were current and 32.6% former smokers; among former vapers, 47.9% were current, 47.9% former smokers and 4.2% non-smokers Those n=18 unaware of vaping products were excluded from these calculations	Moderate risk (5/10)
Mark et al. 2015 [210]	Cross-sectional survey of pregnant women presenting to a single outpatient clinic (convenience sample)	Ever vaping: 13%, one ever vaper had never smoked Current daily vaping: 0.6% (2 of 316)	Moderate risk (6/10)
Oncken et al. 2017 [211]	Cross-sectional survey of pregnant women presenting to one of 2 medical centres in the US (data from smoking cessation RCT)	Ever vaping: 53% Vaping during pregnancy: 14%	Low risk (3/10)
Wedel et al. 2018 [214]	Cross-sectional survey of pregnant smokers presenting to a single perinatal centre (convenience sample)	Ever vaping: 75.3% Current vaping: 5.9%	Moderate risk (4/10)

[1] Assessment of bias completed using Hoy [51].

RQ2: Among people who vape during pregnancy, what patterns of use are identified?

Only 2 studies from the UK reported any information on characteristics of vaping in pregnancy (Table 22). One qualitative study that included most items on the COREQ checklist (as an indicator of high quality) reported that pregnant women preferred convenient and smaller vaping products and that they often used them in similar settings to those used for smoking. Some participants said that they tried to avoid vaping around children [192]. The study reported some awareness of flavours and nicotine strengths, but no preferences for either. Another study, rated as poor quality (using COREQ), reported that, of 29 women attending smoking cessation services, one had vaped every day in the last 30 days, and 3 said they had vaped occasionally [196].

Outside the UK

Frequency of vaping was reported inconsistently and the quality of non-UK studies varied (Table 22). Daily use was reported for 0.6% of one clinic sample [210] and 3% of a survey sample [197], equating to 5% to 6% of those who had ever vaped. One cohort study reported that 20.8% of participants who vaped did so on 10 or more days per month, 29.2% vaped between 3 and 9 times per month, and 50% vaped once or twice per month [199].

Among pregnant women who had enrolled in a text messaging trial for smoking cessation (which did not target vaping), over half of those who vaped at baseline had stopped at 1-month follow-up (Table 22) [200].

One study reported on preferences for vaping flavours [212]. In this study of women during the peripartum period, fruit flavours were the most commonly used, preferred by 69% of participants, followed by candy and mint, with tobacco flavour relatively unpopular as a preference for 13% of participants (Table 22).

One study reported that 50% of vapers used pre-filled cartridges [211], none of the other studies reported type of vaping device used (Table 22).

Just one study reported on the nicotine content of participants' vaping products, reporting that 38% of pregnant vapers used nicotine and 35% used nicotine-free vaping products [206] (Table 22).

Table 22: Characteristics of use

Paper ID	Frequency, flavours, nicotine, other characteristics	Quality assessment[1]
UK studies		
Bowker et al. 2018 [192]	Participants reported vaping at home or with friends and family and said that they vaped in similar environments as for smoking. Some said they avoided vaping in front of children. There was preference for lighter and smaller vaping products, convenience was important. Most were aware of the range of flavours available; some were aware of the range of nicotine strengths available. Frequency of vaping out of 20 current and former users (n): Tried only: 8 Non-daily: 5 Daily: 7	Consolidated criteria for reporting qualitative research (COREQ): 27/32
Mann and Faflik 2018 [196]	Number of days vaped in the last 30 days out of 20 who had ever tried (n): Every day: 1 Occasionally: 3 N/A: 20	Newcastle Ottawa Scale (NOS): Poor quality
Non-UK studies		
Ashford et al. 2016 [197]	Frequency of vaping in 100 participants: Daily: 3% Often: 4% Occasionally: 8% Not used in last 30 days: 33% Never used: 52%	NOS: Poor quality
Cardenas et al. 2019 [199] Clemens et al. 2019 [201]	Frequency of vaping in 24 past-month vapers (n): Daily to 10 days per month: 5 3 to 9 times per month: 7 1 to 2 times per month: 12	NOS: Fair quality *(for both studies)*
Chiang et al. 2019 [200]	Of 36 women who at baseline had vaped in the past 7 days, 16 continued vaping at 1 month, 20 had stopped vaping. Of 392 non-vapers (but smokers) at baseline, 14 (3.6%) started vaping.	NOS: Good quality
Kapaya et al. 2019 [206]	Among those who vaped during last trimester, 38.4% used nicotine, 35.2% no nicotine, 26.4% did not know	NOS: Low quality
Kurti et al. 2017 [208]	Among 34 current vapers, mean numbers of days vaping in the past month: 13.1	NOS: Good quality
Mark et al., 2015 [210]	Among 42 ever vapers, 2 (4.8%) reported current daily use	Hoy: Moderate risk (6/10) NOS: Poor quality
Oncken et al. 2017 [211]	Among 14 who vaped during pregnancy: Mean (SD) length of use: 7.5 (10.3) days Number of times vaped per day: range from 1 to 25 Used pre-filled cartridges: n= 7	NOS: Good quality

Paper ID	Frequency, flavours, nicotine, other characteristics	Quality assessment[1]
Stroud et al. 2019 [212]	Flavours used among 16 women who vaped during peripartum period (n) Fruit: 11 Candy: 3 Mint: 2 Tobacco: 2 Spice: 1 Coffee: 1	COREQ: 20/32

[1]Assessed using the Consolidated criteria for reporting qualitative research (COREQ) [53] and the Newcastle Ottawa scale (NOS) [52]or Hoy assessment of bias [51].

RQ3: Among people who vape during pregnancy, what reasons for use and what perceptions are identified?

UK

Four qualitative studies [191, 192, 194, 195] and a small survey study [196] reported on reasons for use or perceptions. Quality of reporting varied for qualitative studies from 15 [195] to 28 [191] of the 32 COREQ items, the single small survey [196] study was rated as poor quality (Table 23).

Reasons for use
Two qualitative studies and the small survey study covered reasons for vaping among pregnant women in UK settings (Table 23); common reasons mentioned were to stop smoking or to prevent a return to smoking [192, 195, 196] and to reduce harm to themselves, their baby and others [192, 196]. One study reported that some participants who had quit smoking when pregnant intending to resume smoking post-partum had used vaping products to prevent a return to smoking [195].

Perceptions and attitudes
A dominant theme in qualitative studies and the survey study was uncertainty about the harms or risks of vaping and of nicotine in pregnancy (Table 23). Pregnant smokers were concerned that they did not know enough about the risks of vaping to use vaping products [191]. In a small cross-sectional survey, three-quarters of participants said that they did not know if vaping was less harmful than smoking [196] and in one qualitative study, participants considered vaping 'worse' than smoking in pregnancy with cutting down on smoking perceived to be safer than vaping or NRT [194]. Specific concerns included the heightened importance of protecting the welfare of the unborn baby, nicotine from vaping in breastmilk and the potential for harm from vaping while breastfeeding [195].

One qualitative study explored pregnant vapers' experiences of stigma [192]. Participants reported feeling uncomfortable when vaping in public because they feared being judged by others. However, some added that they felt vaping was more socially accepted than smoking when pregnant [192, 194]. Posts on online forums also included statements by people who said that vaping had helped them to address nicotine cravings and withdrawal. They also commented that vaping helped them to cope with the stresses of pregnancy and caring for a newborn baby and that without vaping they felt they would be more stressed, which could have a negative impact on their baby [195].

Sources of information
Although not one of our research questions, we briefly report on the sources of information from which pregnant women learned about the health implications of

vaping. These were discussed in 3 studies [192, 194, 195] with a common theme of lack of evidence and lack of reliable information (Table 23). On discussion boards, evidence cited most often came from media articles, blog posts and other social media discussions. Anecdotal evidence was accepted as most substantial form of evidence, while evidence from professional sources such as NHS or PHE was often misinterpreted [195].

Outside the UK

Five qualitative studies and 9 surveys explored reasons to vape and perceptions of vaping. Quality of reporting for qualitative studies ranged from 16 [205] to 31 [216] out of the 32 items on the COREQ checklist; surveys included some of poor quality [197, 198, 210], one of fair quality [214] and some of good quality [200, 206, 211, 213] (Table 23).

Reasons for vaping
Reasons for vaping were reported by 2 qualitative studies [203, 204] and 6 surveys [197, 198, 200, 206, 210, 211], all from the US (Table 23). A desire to reduce or quit smoking, and the belief that vaping was less harmful than smoking, was reported in all these studies. Other reasons for vaping included being able to vape in smokefree areas, curiosity, price, similar hand-to-mouth action as cigarettes, and taste. Some participants in online forums said that they smoked to avoid nicotine withdrawal which they thought was harmful or unsafe for their unborn baby [217].

Perceptions and attitudes
Perceptions and attitudes about the risks of vaping among pregnant women were assessed in 5 qualitative studies [203-205, 216, 217] and 6 surveys [197, 198, 210, 212-214] from outside the UK (Table 23).

Harm perceptions, often relative to smoking, were explored in 9 studies. Qualitative evidence showed conflicting perceptions, including that vaping is less harmful than smoking [203, 205] and is an effective harm reduction approach [205, 216] but also that vaping is not safe in pregnancy [205], likely to harm the baby [205, 216], has unknown risks and that the risks relative to tobacco cigarettes are unclear [216, 217]. Nicotine was singled out as a cause for concern [216, 217] with some commenting they perceived that abstaining from nicotine would carry risks to women and their babies [217]. Lack of research was highlighted in 2 studies [216, 217].

Some surveys also assessed harm perceptions [197, 198, 210, 212, 213]. In one survey of pregnant and non-pregnant women, 11% saw 'e-cigarettes' as a serious hazard, 20% not at all as a hazard, with the remaining split between moderate (31%) and minor (38%) hazard; never vapers may have been more likely to perceive 'e-cigarettes' as a serious hazard [197]. Among a sample of pregnant women, concern that vaping may harm their baby received slightly lower

agreement than concern that smoking cigarettes may harm the baby, but differences were not tested for statistical significance [198]. There was also moderate agreement that vaping caused lung cancer and can cause harm to others nearby [198]. In another survey of pregnant women, the majority of ever vapers agreed that vaping was less harmful to themselves (78%) and to a baby (68%); among never vapers, 31% agreed with each statement [210]. However, the study did not specify what vaping should be compared with. In another survey, 64% of pregnant women agreed that vaping was safer than smoking generally [213], 35% agreed that vaping products were safer than tobacco cigarettes for pregnant women and 55% agreed that vaping products and cigarettes posed similar health risks. Stroud and colleagues [212] analysed pregnant women's perceptions of harm relating to different flavours and found very small differences between flavours.

Perceptions that vaping was helpful for smoking cessation were reported (with some ambivalence) by pregnant women in 2 studies [205, 216], and this perspective also found moderate to high level of agreement in a survey [198]. In one study, about half of a sample of pregnant women who smoked said they would consider using a second- or third-generation device for smoking cessation or reduction while pregnant or would consider vaping after their baby was born [214].

Other topics were reported in fewer studies. One study focused more on positive and negative experiences of using vaping products [204], one mentioned social stigma and lack of satisfaction [216]; 2 mentioned that vaping was cheaper than smoking [210, 216]. One qualitative study identified perceptions that quitting vaping 'cold turkey' (unaided) would be unsafe and identified strategies for perceived safe vaping [217]. Fewer than 20% of pregnant women in one survey agreed that vaping was fashionable, but 31% agreed that they contain tobacco [210]. Most pregnant participants agreed that vaping products should not be sold to minors (90%) and should be regulated like cigarettes (68%) [213]. Mixed messages from health providers and lack of evidence were reported [204, 213, 216, 217].

Table 23: Reasons for vaping and perceptions

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information	Quality assessment[1]
UK Studies			
Qualitative studies			
Bowker 2016 [191]		Majority reluctant to use them due to uncertainty surrounding their safety 5 in 14 had vaped during their pregnancy; 2 continued to use them alongside NRT products, 3 decided to discontinue vaping following safety discussions with friends or their smoking advisor Women who continued to vape felt they were not helpful to their quit attempt	Consolidated criteria for reporting qualitative research (COREQ): 28/32
Bowker 2018 [192]	Most were motivated to quit smoking Some felt that vaping could help them quit Dual users of vaping products and cigarettes felt that vaping helped them to reduce their smoking Majority believed they were less harmful (to fetus) Reduced smoke odour Safer for second-hand exposure Cheaper Replicated and substituted smoking Encouraged to quit using vaping products by family, friends or health professional Curiosity	**Social stigma** Most women felt uncomfortable about vaping in public during pregnancy Felt that they would be judged and perceived as a bad mother Some felt it was more socially acceptable to vape than to smoke and felt empathetic as they could relate to the struggles of cessation Some expressed strong belief that it was socially unacceptable for a pregnant woman to smoke or vape in public **Harm perception, sources of information** Lack of information about safety Worried vaping might increase consumption of nicotine Concerns about safety heightened by negative media reports, referring to malfunctioning devices, links to cancer or other health harms Many had not received instructions about their device from the retailer or from the vaping product packaging, leaving some feeling uninformed. Rather than receiving information about vaping products from retailers, participants would prefer information from a health professional or through National Health Service leaflets or websites	COREQ: 27/32
Johnson et al. 2019 [194]	Not reported	All participants described vaping products as harmful in pregnancy and considered them worse than cigarettes Had heard about harm from friends and health professionals and those who sold vaping products. Cutting down considered less harmful than NRT or vaping	COREQ: 23/32

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information	Quality assessment[1]
Johnston et al. 2019 [195]	Some people used vaping products to prevent returning to smoking. They used them to deal with post-partum cravings for nicotine, often triggered by the demands of motherhood, mental health issues, lack of sleep, stress, loss of identity and relationship issues Some had quit smoking with the intention of starting again post-partum, but had, instead, used vaping products	**Perceptions** Less harmful than cigarettes Concerns about welfare of their child Concerns about potential future health implications that are not yet known Discussion about nicotine in breastmilk and concern that baby would suffer nicotine withdrawals when breastfeeding stopped Without vaping they would be more stressed, would have negative impact on baby Some compared the effects of vaping to the effects of drinking coffee Concerns about second-hand exposure Lack of evidence on safety, lack of evidence on vaping and breastfeeding or vaping around children **Sources of information** Professional evidence came from academic articles or via professional websites such as the National Health Service (NHS) and Public Health England (PHE). This evidence was often misinterpreted, particularly by those who were opposed to vaping Most commonly shared evidence from media articles, blog posts, social media discussions. Websites, such as Wikipedia, being cited as sources of evidence against vaping Non-professional evidence mostly quoted by those opposed to vaping, whereas professional evidence was equally shared by those both for and against vaping Anecdotal evidence shared by both sides, appeared to be the most substantial form of evidence accepted Some mistrust at the science itself, but also the institutions that make the recommendations.	COREQ: 15/32

Survey study

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information	Quality assessment[1]

Mann and Faflik 2018 [196]	May help me quit smoking: 7/10
	May help reduce cravings or withdrawal symptoms: 7/10
	May help me cut down smoking: 3/10
	Can use in addition to smoking: 3/10
	Can use in public place where smoking not allowed: 2/10
	Doesn't contain harmful chemical: 1/10
	Would replace cigarettes: 1/10
		There might be disadvantages: 15/29
		Not sure pregnant women should have the choice to vape to help them quit smoking: 18/29
		Vaping during pregnancy is
		   - less harmful than regular (tobacco) cigarettes: 3/29
		   - more harmful than regular (tobacco) cigarettes: 3/29
		   - about the same harm than regular (tobacco) cigarettes: 1/29
		   - don't know: 22/29
			Newcastle Ottawa Scale (NOS): Poor quality

Non-UK studies

Qualitative studies

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information	Quality assessment[1]
England et al. 2016 [203]	Cheaper price No ash No unpleasant odours Use in smokefree areas Appealing flavours Help with smoking cessation Being able to see the vapour Similarities to traditional cigarettes Less harmful Can be used around children	Concerned about lack of evidence about safety Less harmful than cigarettes	COREQ: 23/32

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information	Quality assessment[1]
Fallin et al. 2016 [204]	Harm reduction strategy Preferred vaping over traditional cessation products	**Positives** Variety of flavours Ability to choose nicotine dose Possibility to conceal illicit substance use (marijuana) **Negatives** Frustration with equipment, batteries Less satisfying than smoking Discomfort associated with use **Sources of information** Reported mixed messages from health care providers	COREQ: 23/32
Kahr et al. 2015 [205]	Not assessed	**Positives** May be used as smoking cessation device Generally, vaping products are safer, healthier (lack of second-hand smoke, vapour, fewer chemicals, indoor use) **Negatives** Not safe in pregnancy Likely to harm baby Can be addictive **Ambivalent** As bad as regular cigarettes during pregnancy, but not if used as smoking cessation device Mother who uses vaping products during pregnancy not taking care of baby, but may be using them to reduce risks to her child	COREQ: 31/32
Schilling et al. 2019 [216]	Not assessed	**Positives** Harm reduction potential, less harmful than cigarettes Potential to help smoking cessation. Partly by imitating hand to mouth behaviour. Many reported using nicotine free vaping products for this purpose Perceptions that vaping products were cheaper than cigarettes **Negatives** Perceived nicotine as one of the most harmful ingredients in vaping products for unborn babies, causing risks to the respiratory tract and nicotine addiction Unclear about potential health risks of other ingredients Unclear about risks relative to tobacco cigarettes Lack of satisfaction Social stigma **Information** Lack of research studies on vaping during pregnancy	COREQ: 16/32

Paper ID	Reasons for vaping			Perceptions and attitudes of pregnant women, sources of information					Quality assessment[1]
Wigginton et al. 2017 [217]				Three discursive strategies identified 1) Happy mum, healthy baby: quitting (nicotine) 'cold turkey' is unsafe Abstaining from nicotine "unsafe" or "unhealthy", significant risks to women and their babies Harm reduction approach to avoid stress/harm of quitting while reducing nicotine (NRT, vaping, or reduced smoking) 2) Vaping is the lesser of two evils Vaping as safer than smoking "Safe vaping" as vaping no nicotine or flavourings, researching products Similarity of vaping to NRT 3) Vaping is not worth the risk Unknown risks Safety only through abstinence Lack of research on vaping					COREQ: 12/32

Survey studies

Paper ID	Reasons for vaping	Current vapers (n=49), %	Former vapers (n=77), %	E-cigarettes as hazard	All (N=194)	Current vapers (n=49), %	Former vapers (n=77), %	Never vapers (n=68), %	Quality assessment[1]
Ashford et al. 2016 [197]									NOS: Poor quality
	Wanted to quit smoking	51	55	Serious	10.9	8	7	18	
	Less harmful to others	37	13	Moderate	30.6	25	42	22	
	Thought it would be less expensive	35	26	Minor	38.3	40	39	37	
	Can use where smoking not allowed	35	17	Not at all	20.2	27	13	24	
	Less harmful to myself	35	14						
	Became pregnant	25	3						
	Like taste	23	5						
	Saw ads promoting vaping	16	12						
	Maintain / lose weight	2	1						

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information				Quality assessment[1]
Bhandari et al. 2018 [198]	Ever vaped because trying to quit smoking: Current vapers: 70.5% Former vapers: 54.9%	**Scores ranged from 1 to 5, higher scores represent higher degree of agreement** *(questions reproduced here verbatim)*	**Current vapers (n=44), M (SD)**	**Former vapers (n=71), M (SD)**	**Never vapers (n=255), M (SD)**	NOS: Poor quality
		If a pregnant woman smokes tobacco cigarettes her baby may be harmed	4.30 (0.82)	4.11 (1.13)	4.67 (0.67)	
		If a pregnant woman smokes e-cigarettes her baby may be harmed	3.39 (0.81)	3.75 (0.79)	3.96 (0.89)	
		E-cigarettes cause lung cancer	3.20 (0.93)	3.52 (0.91)	3.69 (0.99)	
		The exhaled smoke from vaping can cause harm to others nearby	2.55 (1.13)	2.83 (1.09)	3.44 (1.15)	
		Once someone has started smoking e-cigarettes, how easy do you think it is to quit?	2.89 (1.04)	2.90 (1.17)	2.63 (1.04)	
		E-cigarettes can help tobacco users to quit smoking.	3.61 (1.20)	3.25 (1.21)	3.06 (1.13)	
Chiang et al. 2019 [200]	Among n=36 who had vaped in past 7 days: Help me quit: 81% Safer for me than regular cigarettes: 42% Taste good and does not smell: 39% Safer for my baby than regular cigarettes: 36% Cost: 14% Friends and family use them: 6%	Not assessed				NOS: Good quality
Kapaya et al. 2019 [206]	Among n=285 who vaped around time of pregnancy Curiosity about products: 54.0% Help with quitting or reducing smoking: 45.2% Less harmful to mother: 45.2% Availability of flavours: 42.3% Ability to get devices without nicotine: 41.4%	Not assessed				NOS: Good quality
Mark et al. 2015 [210]	Among 100 ever vapers: Less harmful to users' health: 74% Assistance with smoking cessation: 73% Can be used in places where cigarettes banned: 55% Taste better: 54%	**E-cigarettes…** *(questions reproduced here verbatim)*	**Overall (n=200), %**	**Ever vapers (n=100), %**	**Never vapers (n=100), %**	NOS: Poor quality
		Are less harmful to me	45	78	31	
		Are less harmful to a baby	43	68	31	
		Are cheaper	31	61	18	
		Are fashionable	18	27	14	
		Contain nicotine	57	63	55	
		Can be addictive	61	62	60	
		Contain tobacco	31	29	31	
Oncken et al. 2017 [211]	Among 14 who vaped during pregnancy: To quit smoking: 57% To reduce smoking: 36% Curiosity: 36% Availability: 21% Health benefits: 7%	Not assessed				NOS: Good quality

Paper ID	Reasons for vaping	Perceptions and attitudes of pregnant women, sources of information			Quality assessment[1]
Stroud et al. 2019 [212]	Not assessed	Scale of 1 to 7, 1 indicating lowest risk			COREQ: 20/32
		Flavour	**Pregnancy risk, M (SD)**	**Fetal health risk, M (SD)**	
		Fruit	6.46 (1.19)	6.37 (1.27)	
		Candy	6.51 (1.09)	6.40 (1.22)	
		Mint/menthol	6.49 (1.18)	6.43 (1.17)	
		Alcohol	6.56 (1.04)	6.45 (1.16)	
		Coffee	6.52 (1.07)	6.40 (1.17)	
		Chocolate	6.47 (1.16)	6.40 (1.22)	
		Spice	6.50 (1.10)	6.42 (1.17)	
		Tobacco	6.58 (1.02)	6.48 (1.09)	
		N=100			
Wagner et al. 2017 [213]	Not assessed	Safer than tobacco cigarettes: 64.3% Safer than tobacco cigarettes for pregnant women: 35.3% Pose similar health risks as tobacco cigarettes: 55.3% Should be regulated like tobacco cigarettes: 67.8% Should not be sold to minors: 89.9% Of the n=50 who switched or started vaping when they learnt that they were pregnant, 23 (46%) did so because they saw them as safer than tobacco cigarettes, 9 (18%) did so to quit tobacco cigarettes and 2 at the direction of their health provider.			NOS: Good quality
Wedel et al. 2018 [214]	Not assessed	*(Items reproduced here verbatim)*	Would consider using to quit smoking or reduce smoking while pregnant, N (%)	Would consider using after baby is born, N (%)	NOS: Fair quality
		1st generation e-cigarette	22 (26)	25 (29)	
		2nd and 3rd generation e-cigarette	43 (51)	46 (54)	
		Participants who had ever vaped were significantly more willing to use vaping products while pregnant (p=0.028) and after pregnancy (p=0.17) Levels of worry about smoking, perceptions of how important it was to quit smoking and confidence that they were able to quit smoking during pregnancy were not associated with interest in vaping			

Abbreviations: NRT, nicotine replacement therapy; [1]Assessed using the Consolidated criteria for reporting qualitative research (COREQ) [53] and the Newcastle Ottawa scale (NOS) [52].

RQ4: What are the effects of vaping on smoking cessation or reduction during pregnancy and post-partum?

UK

None of the studies from the UK reported smoking cessation outcomes from vaping among pregnant women. One study that analysed the content of online forums (and missed many items on the COREQ reporting checklist) reported posts claiming that women had quit smoking when pregnant using vaping products and had then continued to use these products to remain abstinent from smoking postpartum [195] (Table 24).

Outside the UK

One study of good quality reported data on longitudinal associations between vaping and smoking cessation [200] using secondary data from a trial of a text-messaging program for smoking cessation. At baseline, 36 women had vaped in the past 7 days, 392 women had not vaped. At 1-month follow-up, the 2 groups had similar odds of having been abstinent from smoking for 7 days and having tried to quit smoking (Table 24).

Three additional studies [207, 210, 211] reported information related to smoking cessation but did not assess associations between vaping and changes in smoking behaviour.

Motivation to quit smoking was higher in ever vapers compared with never vapers in one survey [210] but similar for current vapers and non-vapers in another [211] (Table 24). Current vapers had made more quit attempts than non-vapers in one survey [211] but ever vapers had not made more quit attempts than never vapers in another survey [210].

In a longitudinal survey of women who became pregnant between survey waves, 81% of women who vaped before they became pregnant quit vaping and only 53% of women who smoked before they became pregnant quit smoking [207]. The study did not test whether vaping was associated with smoking cessation or changes in smoking behaviour (Table 24).

Table 24: Smoking behaviour outcomes

Paper ID	Smoking behaviour outcomes	Quality assessment[1]
UK studies		
Johnston et al. 2019 [195]	Some mothers had quit smoking during pregnancy with the intention of resuming post-partum. Some had then used vaping to stay smokefree following the birth	Consolidated criteria for reporting qualitative research (COREQ): 16/32
Non-UK studies		
Chiang et al., 2019 [200]	**7-day point prevalence smoking abstinence** at 1-month follow-up for participants who - did not vape across both time points: 26.4% (99/375) - vaped at baseline (defined as vaping in past 7 days) but not at follow-up: 25.0% (5/20) - vaped across both time points: 12.5% (2/16) - did not vape at baseline but at follow-up: 7.14% (1/14) All participants who vaped at baseline: 19.4% (7) 7-day point prevalence smoking abstinence, did not vape at baseline: 25.8% (101), unadjusted odds ratio (95% confidence interval): 0.70 (0.30 to 1.64); adjusted: 0.79 (0.33 to 1.92). **Made quit attempt of at least one day**: Vaped at baseline: 69.4% (25); did not vape at baseline: 67.6% (265); OR (95% CI): 1.09 (0.52 to 2.28); adjusted OR (95% CI): 1.20 (0.56 to 2.55) **Reduction in cigarettes per day**, mean (standard deviation): Vaped at baseline: 3.39 (5.5), Did not vape at baseline: 3.4 (5.0)	Newcastle-Ottawa Scale (NOS): Good quality
Kurti et al., 2018 [207]	**Proportion of those using the relevant product at wave 1 who reported no current use at wave 2:** **No current use at wave 2, i.e. 'quit', Prevalence (95% CI)** Wave 1 use / Cigarettes / E-cigarettes / Hookah / Cigar / Any product Overall — 53.4 (43.2, 63.7) — 81.3 (59.8, 100.0) — 98.3 (94.9, 100.0) — 88.0 (76.4, 99.7) — 58.7 (49.2, 68.2) Established users — 48.6 (37.5, 59.7) — 71.2 (38.7, 100.0) — 100.0 (100.0, 100.0) — 83.0 (65.6, 100.0) — 51.2 (41.3, 61.1) Experimental users — 77.4 (56.4, 98.5) — 100.0 (100.0, 100.0) — 97.3 (91.9, 100.0) — 92.4 (76.8, 100.0) — 87.2 (74.1, 100.0)	NOS: Good quality
Mark et al., 2015 [210]	Mean (SD) **seriousness of trying to quit smoking** (range 1-10): Ever vapers: 6.0 (4.4), never users: 5.4 (4.6), p=0.004 **Ever tried to quit smoking**: Ever vapers: 92%, never vapers: 87%, p=0.54, Mean (SD) **number of quit smoking attempts**: Ever vapers: 2.8 (3.2), never vapers: 0.9 (2.9), p=0.78	Hoy: Moderate risk (6/10) NOS: Poor quality
Oncken et al., 2017 [211]	Mean (SD) **motivation to quit smoking** (range 0-10): vapers (n=14: 8.1 (1.3), non-vapers: 8.4 (1.8), p=0.36 **Smoking quit attempts**: < 2: vapers: 29%, non-vapers: 55% 3: vapers: 14%, non-vapers: 21% 4: vapers: 36%, non-vapers: 8% >4: vapers: 21%, non-vapers: 16% p=0.018	NOS: Good quality

[1]Assessed using the Consolidated criteria for reporting qualitative research (COREQ) [53] and the Newcastle Ottawa scale (NOS) [52] or Hoy assessment of bias [51].

RQ5: What health outcomes have been reported in studies of vaping in pregnancy and what findings have been reported for these outcomes?

UK

No studies from the UK reported on pregnancy or maternal health outcomes related to vaping.

Outside the UK

Two articles reported on pregnancy health outcomes [199, 201] (Table 25). Both articles were of fair quality and reported data from a single study in the US. They reported on a cohort study of 248 pregnant women of whom 6 were categorised as exclusive vapers, 17 as dual users who vaped and smoked, 56 as current smokers and 64 as unexposed to vaping or smoking (including second-hand exposure) [199, 201]. Compared with those unexposed to vaping or smoking, babies born to dual users (vaping and smoking) had a relative risk for smallness for gestational age of 2.5 (95% CI: 0.7 to 8.8), similar to the relative risk of those born to smokers (2.6, 95% CI: 0.9 to 7.2, Table 25). The relative risk among people who had vaped only compared with those not exposed was 5.1 (95% CI: 1.2 to 22.2).

However, Cardenas and colleagues [199] commented that the sample size (6 exclusive vapers) was extremely small; the authors stated that: "a well-powered study to detect a 2-fold to 3-fold increase in risk of smallness for gestational age, assuming a 12% risk of smallness for gestational age among pregnant women not vaping or smoking (ie. the referent group), would require about 300 participants per group (eg. vaping and cigarette dual users, vapers who don't smoke, cigarette smokers who don't vape, and the referent group)." (p10). Additionally, it was unclear if abstinence from smoking had been verified for participants categorised as vaping only.

In a subsample of the same study that did not include any exclusive vapers, the presence of biomarkers in the hair was analysed [201]. Raw levels of cotinine and the tobacco-specific nitrosamines 4-(methylnitrosamino)-1(3-pyridyl)-1-butanone (NNK) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) were all higher among dual users than among those not exposed to smoking or vaping, but these differences were non-significant, probably due to small sample sizes. When splitting the sample by nicotine level instead of self-reported smoking and vaping status, those with higher nicotine levels (which we presume were smokers and dual users) had an increased risk of babies that were small for gestational age (Table 25). No comparisons are available for exclusive vapers.

Table 25: Pregnancy and maternal health outcomes

Paper ID	Baby health outcomes	Maternal health outcomes	Quality assessment[1]
Cardenas et al., 2019 [199]	**Risk of smallness for gestational age in** Unexposed, including to second-hand exposure (n=97): 11.3%, referent Dual (vapes and cigarettes) users (n=17): 23.5%; RR (95% CI) = 2.1 (0.7-5.8) Vapes only (n=6): 33.3%; RR (95% CI) = 2.9 (0.8-10.4) Current smokers only (n=56): 23.1% RR (95% CI) = 2.0 (1.0-4.3) After removing inconsistent self-report for 'unexposed group' and adjusting for maternal age and race/ethnicity Unexposed, including to second-hand exposure (n=64): 7.8%, referent Dual (vapes and cigarettes) users (n=17): 23.5%; RR (95% CI) = 2.5 (0.7-8.8) Vapes only (n=6): 33.3%; RR (95% CI) = 5.1 (1.2-22.2) Current smokers only (n=56): 23.1% RR (95% CI) = 2.6 (0.9-7.2)	N/A	Newcastle-Ottawa Scale (NOS): Fair quality
Clemens et al., 2019 [201] Subsample of Cardenas et al	**Risk of smallness for gestational age** By self-report: Non-vapers non-smokers (n=38): 7.9%, referent Smokers (n=27): 25.9%, adjusted RR (95% CI) = 3.9 (1.1 to 13.6) Dual users (n=11): 27.3%. adjusted RR (95% CI) =3.9 (0.9 to 16.2) By hair nicotine level: < 2.77 ng/ml: 3.3%, referent ≥ 2.77 ng/ml: 26.1%, adjusted RR (95% CI) =7.7 (1.1 to 56.0) By self-report confirmed by hair nicotine level: Non-vapers non-smokers (n=25): 4.0%, referent Smokers (n=24): 29.2%, adjusted RR (95% CI) = 7.8 (1.0 to 59.0) Dual users (n=9): 33.3%, adjusted RR (95% CI) = 3.9 (1.0 to 69.1)	**From analysis of hair samples** Nicotine-derived nitrosamine ketone (4-(methylnitrosamino)-1(3-pyridyl)-1-butanone (NNK): Detected in 20% of hair samples from self-reported non-vapers non-smokers, 78% of self-reported dual users and 56% of self-reported smokers. (4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL): Detected in 50% of hair samples from self-reported non-vapers non-smokers, 67% of self-reported dual users and 49% of self-reported smokers. *(see table below)*	NOS: Fair quality

		Self-reported	
	non-vapers non-smokers	dual users	smokers
Nicotine, ng/mg			
Geometric mean (95% CI)	1.1 (0.6-2.0)	11.0 (3.8-31.3)	10.6 (6.5-17.4)
Median	0.83	9.0	10.7
Range	0.1-44.6	0.7-125.6	0.8-102.4
Cotinine, pg/mg			
Geometric mean (95% CI)	0.000 (0.000-0.001)	0.153 (0.004-5.316)	0.065 (0.009-0.465)
Median	0.000	0.671	0.610
Range	0.0001-1.713	0.019-20.955	0.037-6.106

Paper ID	Baby health outcomes	Maternal health outcomes			Quality assessment[1]
		NNK, pg/mg			
		Geometric mean (95% CI)	0.003 (0.001-0.011)	0.213 (0.006-7.672)	0.131 (0.019-0.88) 1.299
		Median	0.000	6.095	0.000-27.192
		Range	0.000-42.276	0.000-105.163	
		NNAL, pg/mg			
		Geometric mean (95% CI)	0.004 (0.001-0.013)	0.030 (0.002-0.395)	0.005 (0.001-0.025)
		Median	0.000	0.135	0.000
		Range	0.000-0.929	0.000-1.863	0.000-1.081

[1]Assessed using the Consolidated criteria for reporting qualitative research (COREQ) [53] and the Newcastle Ottawa scale (NOS) [52]

RQ6: What are the reported barriers to, and facilitators of, vaping in pregnancy?

UK

Four studies reported barriers to, and facilitators of, vaping in pregnancy in the UK; quality of reporting ranged from fulfilling 19 [196] to 28 of 32 [193] items on the COREQ checklist (Table 26).

Two studies reported the perspectives of pregnant women [191, 194]. In these studies women said that they had heard negative views about the risk of vaping in pregnancy. That midwives had not recommended vaping in pregnancy had influenced a pregnant woman to stop vaping [191]. Two studies reported on the views of smoking cessation services [193, 196]. Mann and Faflik [196] reported that 69% of services surveyed said that vaping in pregnancy was a personal choice. Cooper and colleagues [193] reported a range of attitudes with some services supporting vaping and others saying that vaping in pregnancy went against medical advice.

Two studies reported barriers and facilitators to vaping from the perspective of health professionals from the UK (Table 26). Stop smoking service managers [193] said that the lack of a licensed product was a barrier to issuing vaping products or health professionals recommending them as a quitting aid. They also commented that local healthcare policies could restrict their ability to innovate in stop smoking services and could prevent autonomy. The study participants reported that local commissioners will sometimes take account of local or national guidance on vaping, but often remain sceptical. The study also reported that PHE reports on vaping were welcomed by health professionals and had engendered what they termed as a positive shift towards vaping. In another study [196], people working in smoking cessation service also said that PHE reports were the most commonly used resource for influencing vaping advice, followed by Action on Smoking and Health (ASH), local practitioner knowledge, National Institute for Health and Care excellence (NICE) smoking cessation guidelines, the NHS smokefree website, academic journals and professional practitioner focused journals. However, they noted that 6 in 10 services had no local protocols on the use of vaping products in pregnancy [196].

Outside the UK

Only one study from outside the UK described the views of health professionals (Table 26) [202]. Around 3 in 10 US obstetrician-gynaecologists agreed that vaping had adverse health effects but was safer than smoking, just over 1 in 8 thought vaping was as harmful as smoking, and 1 in 8 thought vaping had no health

effects. Over a third said they did not know about the relative safety of vaping and smoking and over two-thirds said they wanted more information on the risks.

None of the identified studies explored barriers and facilitators among health professionals in other countries.

Table 26: Perceptions of professionals, barriers and facilitators

Paper ID	Perceptions and attitudes of professionals	Barriers and facilitators, sources of information	Quality assessment[1]
UK studies			
Bowker et al., 2016	Some pregnant women said they had stopped vaping when they found out that midwives did not recommend them	Not reported	COREQ (28/32)
Cooper et al. 2019 [193]	Range of acceptance from welcoming to "against medical advice" Majority do not recommend as first choice Desire for more evidence on the effectiveness and safety of vaping in pregnancy (especially long-term), particularly the safety of the baby	PHE national vaping guideline welcomed − "reliable", "trustworthy", encouraged a positive shift towards vaping As vaping products are not licensed, they cannot be prescribed/issued by health professionals − barrier to embracing them as a quit aid Local commissioning policies restrict ability to improvise and innovate, position on vaping laid down by commissioners However, many commissioners take on board the national guidance, though continue to be sceptical which harms stop smoking services	COREQ (28/32)
Johnson et al. 2019 [194]	Negative views of vaping among participants were informed by health professionals, however the perceptions of those health professionals were not directly reported	Not reported	COREQ (23/32)
Mann and Faflik 2018 [196]	Smoking cessation services: 69% advised pregnant women that their use of vaping products was a personal choice	PHE report on vaping most frequently cited for formulating advice (31 out of 36 services), then Action on Smoking and Health (20), local smoking cessation service practitioner knowledge/ experience (19), NICE smoking cessation guidelines (17), guidance from NHS Smokefree (11), evidence from academic research journals (9), National Centre for Smoking Cessation and Training (0), evidence from professional/ practitioner-focused journals (5) 60% of services had no local protocol to advise pregnant women about vaping	COREQ (19/32)
Non-UK studies			
England et al., 2014 [202]	Have adverse health effects but safer than cigarettes: 29.0% Have same health effects as cigarettes: 13.5% Have no health effects: 13.5% Don't know about relative safety: 36.5% Want to know more about potential health effects: 67.5%	Not reported	COREQ (24/32)

Abbreviations: NHS: National Health Service; NICE: National Institute for Health and Care Excellence; PHE: Public Health England; [1] Assessed using the Consolidated criteria for reporting qualitative research (COREQ) [53].

Other guidance and ongoing research that the authors are aware of

The Smoking in Pregnancy Challenge Group in England has published a resource on vaping before, during and after pregnancy for maternity and other health professionals which summarises that vaping should be supported if it helps women or households with children to quit smoking or stay smokefree [218].

We are aware of ongoing studies that will provide relevant and much-needed evidence. These include, in no particular order:

An NIHR-funded randomised controlled trial, led by Dr Peter Hajek, Queen Mary, University of London, UK, comparing vaping products with nicotine patches for smoking cessation in pregnancy has recently completed recruitment of just over 1,100 pregnant women (trial registered at https://doi.org/10.1186/ISRCTN62025374).

An observational cohort led by Dr Cheryl Oncken, University of Connecticut, US, aims to recruit 375 pregnant women to compare toxicant exposure and birth outcomes between women who vape and those who smoke (ClinicalTrials.gov identifier: NCT03480373).

Dr Brendan McDonnell and colleagues at Coombe Women and Infants University Hospital, Ireland, are comparing birthweight for pregnant women who are exclusive vapers, smokers or non-smokers. This was due to be published in the British Journal of Obstetrics and Gynaecology on 10 February 2020.

A longitudinal survey of 750 pregnant and postpartum women was led by Sue Cooper and Katharine Bowker, University of Nottingham, UK. The baseline data on more than 3,360 pregnant women who completed screening questions has been written up; this investigates prevalence of dual use and exclusive vaping during pregnancy and compares characteristics of those who use vaping products with those who only smoke. It also examines women's attitudes towards vaping. The longitudinal analysis of the women who vape and/or are current or recent ex-smokers will investigate patterns of vaping across pregnancy and postpartum and will examine information on birthweight and breastfeeding rates. A separate qualitative study on addressing and overcoming barriers to vaping in pregnancy is currently being analysed.

Dr Summer Hawkins at Boston College, US has co-authored a recent publication in the American Journal of Preventive Medicine using 2016 PRAMS data to examine the prevalence and socio-demographic characteristics of vaping during pregnancy among 34,000 women from 29 states and New York City [219] (published after the end date of our search strategy). In a future publication, she will use 2016-17 PRAMS data on over 50,000 women from 31 states to examine associations between vaping and birth outcomes.

Professor Michael Ussher at St George's, University of London and University of Stirling is recruiting 204 women in a CRUK funded study to compare key biomarkers of exposure to nicotine and tobacco products among women who are exclusively using vaping products compared with women who are exclusively smoking, those using combinations of nicotine products and smoking and those who have never used tobacco/nicotine products.

Conclusions

Summary of findings

- our systematic review showed a lack of evidence on the prevalence of vaping in pregnancy in England, the effects of vaping on smoking during pregnancy and following birth, and on the effects of vaping on maternal health or pregnancy outcomes
- as in other populations, pregnant women who vape are likely to do so to stop smoking
- vaping in pregnancy is very rare among those who have not smoked
- pregnant smokers and health professionals are unsure about the relative risks of vaping for mother and baby and clinical practice around vaping in pregnancy varies

Implications

- the lack of nationally representative data on vaping in pregnancy in England need to be addressed through research programmes
- more research is needed on the associations between vaping in pregnancy and smoking cessation and health outcomes
- the common reasons for vaping in pregnancy are to stop smoking, prevent a return to smoking and reduce harms. So, any uncertainty about the harms or risks of vaping in pregnancy is likely to discourage vaping by pregnant smokers
- the inconsistent attitudes of health professionals to vaping in pregnancy show that guidance is urgently needed
- while they await the outcomes of ongoing research, health professionals can use guidance and recommendations from the Smoking in Pregnancy Challenge Group on vaping before, during and after pregnancy, for maternity and other health professionals. The guidance says that vaping should be supported if it helps women or households with children to quit smoking or stay smokefree and that regulated nicotine vaping products will always be preferable to smoking

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Appendices

A Chapter 5: Medline search terms

B Chapter 5: How each study defined i) ever and current vaping ii) smoking status and iii) mental health condition were assessed

C Chapter 5: Risk of bias and quality appraisal table for intervention studies

D Chapter 5: Quality assessment for studies reporting on barriers and facilitators

E Chapter 5: Quality appraisal for qualitative studies using COREQ

F Chapter 6: Measures of smoking and vaping

Appendix A: Medline (OVID) search terms

	1. exp electronic cigarette/
OR	
	2. e-cig*.mp.
OR	
	3. electronic cig*.mp.
OR	
	4. ENDS AND Nicotine.mp.
OR	
	5. electronic nicotine delivery system*.mp.
OR	
	6. ((Nicotine) AND (Vaping* OR Vape* OR Vaporiz* OR Vaporis* OR Vapouris*)).mp.
	7. 1 or 2 or 3 or 4 or 5 or 6
AND	
	8. exp Mental Health Services/
OR	
	9. exp Mental Disorders/
OR	
	10. psychiatric treatment.mp.
OR	
	11. exp Mentally Ill Persons/
OR	
	12. exp Mental Health/
OR	
	13. exp Anxiety Disorders/
OR	
	14. Anxiety.mp.
OR	
	15. exp Mood Disorders/
OR	
	16. mental health.mp.
OR	
	17. exp depression/
OR	
	18. exp Schizophrenia/
OR	
	19. exp "Bipolar and Related Disorders"/
OR	
	20. bipolar.mp.
OR	
	21. exp Stress Disorders, Post-Traumatic/
OR	
	22. PTSD.mp.
OR	
	23. Emotional distress.mp.
OR	
	24. Psychological distress.mp.
OR	
	25. Mental illness.mp.
OR	
	26. Psychiatric.mp.
	27. 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26
	28. 7 AND 27

Appendix B: Definitions of ever and current use of vaping products in mental health studies

Study	Measures of smoking and vaping
Nationally representative	
Cummins et al., (2014) [145]	*Vaping:* Respondents who had ever used e-cigarettes were coded as current users if they had used them in the previous 30 days. (page 49) *Smoking:* Cigarette smoking was assessed using multiple questions with smokers defined as those who had smoked at least 100 cigarettes in their lifetime. Smokers were classified as: current, if they said they smoked 'every day' or 'some days' (when asked 'Do you currently smoke cigarettes every day, some days, or not at all?'), recent former if they smoked within the past year, and long term former if they last smoked over 1 year ago. Never smokers were defined as those who had not smoked 100 cigarettes in their lifetime. (page 49)
Park et al., (2017) [151]	*Vaping:* Ever use of e-cigarettes was defined by an answer of "yes" to the question "Have you ever used an e-cigarette, even one time?" "Exclusive e-cigarette ever-users" were defined as individuals who answered "yes" to the question about ever using an e-cigarette and "no" to the question "Have you smoked at least 100 cigarettes in your entire life?" (page 3) *Smoking:* "Exclusive current cigarette users" were defined as those who had smoked 100 cigarettes in their lifetime, smoked "every day" or "on some days" at the time of the survey, and responded "no" to the question about ever using an e-cigarette. (page 3) *Vaping and smoking:* "Ever e-cigarette users and former cigarette smokers" were defined as those who responded "yes" to the question about ever using an e-cigarette and had smoked at least 100 cigarettes in their lifetime but who had quit smoking at the time of interview. "Current dual users" included current cigarette users and those who answered "yes" to the question about ever using an e-cigarette and answered "every day" or "on some days" to the question "Do you now use e-cigarettes every day, some days, or not at all?" "Non-users" were defined as those who had never used either e-cigarettes or cigarettes. (page 3)
Spears et al., (2017) [154]	*Vaping:* Lifetime ENDS use was assessed by asking whether participants had ever used ENDS, even once or twice. Lifetime ENDS users were then asked, "Do you now use electronic vapor products every day, some days, rarely, or not at all?". Those who responded "every day", "some days", or "rarely" were considered current ENDS users (page 4) *Smoking:* Respondents who reported smoking at least 100 cigarettes in their lifetime were asked, "Do you currently smoke cigarettes every day, some days, or not at all?". Those who responded "every day" or "some days" were considered current smokers, while those who responded "not at all" were considered former smokers. Those who reported that they had not smoked at least 100 cigarettes in their lifetime were considered non-smokers.

205

(page 4)

Spears et al., (2018a) [156]	*Vaping:* Participants were asked whether they had ever used ENDS. Those who answered 'yes' were asked: 'Do you now use electronic vapor products every day, some days, rarely, or not at all?'. Those who indicated now using ENDS 'every day', 'some days' or 'rarely' were considered current ENDS users [51,63]. Those who noted using ENDS 'every day' were considered current daily users. (page 317) *Smoking:* Participants who indicated having smoked at least 100 cigarettes in their lifetime were asked: 'Do you currently smoke cigarettes every day, some days, or not at all?'. Those who responded 'every day' or 'some days' were categorized as current smokers, and those who responded 'not at all' as former smokers. Those who denied having smoked at least 100 cigarettes in their lifetime were categorized as never smokers. (page 317)
Wang et al., (2018) [107]	*Vaping:* Current users of all other tobacco products (including e-cigarettes) were those who reported their use every day or some days at the time of survey. (page 1226) *Smoking:* Current cigarette smokers were those who reported having smoked ≥100 cigarettes during their lifetime and smoked every day or some days at the time of survey. (page 1226)

Non-nationally representative

Bandiera et al., (2017) [140]	*Vaping:* Current use of e-cigarettes was assessed with the question "During the past 30 days, have you used any ENDS product (ie., an e-cigarette, vape pen, or e-hookah), even one or two puffs, as intended (ie. with nicotine cartridges and/or e-liquid/e-juice)?" (page 20) *Smoking:* Current use of cigarettes was assessed with the questions "During the past 30 days, on how many days did you smoke/use _____?" (page 20)
Brady et al., (2019) [142]	*Vaping:* Assessed e-cigarette use by asking, 'are you using e-cigarettes?' at enrolment and 7-month follow-up. In the primary analysis, e-cigarette use reported at the time of enrolment, follow-up, or both were classified as any use. (page 2) *Smoking/quitting (as all were smokers at enrolment):* The primary outcome was tobacco cessation 7-months after enrolment, measured as self-reported, 30-day point prevalence abstinence. (page 2)
Hefner et al., (2019) [146]	*Vaping:* Participants reported their past month frequency of e-cigarette use (none, 1 to 10 days, 11 to 20 days, 21 to 30 days). (page 15) *Smoking:* Current tobacco use was assessed in terms of frequency (every day, some days, none)… in the past 30 days. (page 15)

Smoking and vaping:
Based on reported use of combustible and e-cigarettes, participants were categorized as a never smoker, former smoker, current smoker, whether they had ever tried e-cigarettes, if they were a current e-cigarette user (past 30-day use, any frequency), former e-cigarette use (had tried them but not past-30 day use), current e-cigarette-only user (no combustible tobacco use), current dual use (e-cigarette and combustible cigarette use).
(page 15)

King et al., (2018) [147]	*Smoking/vaping:* We assessed past 30-day tobacco use for the following products: traditional cigar, cigarillo or little cigar, bidi, kretek (aka clove), Gutkha, e-cigarette or electronic cigarette, waterpipe (aka hookah, shisha, narghile), traditional pipe, verve, chewing tobacco, moist or dry snuff (dip), snus, and dissolvables. Participants were asked if they had ever used each product, with response options further clarifying the time period (past week, past 30 days, past 6 months, past year, more than a year ago, or never)… Responses were coded as yes/no for past 30-day use of each tobacco product. (page 68)
Kioi and Tabuchi (2018) [163]	*Vaping:* Participants were asked about their use of each of the following products: nicotine e-cigarettes, non-nicotine e-cigarettes, e-cigarettes with unknown nicotine content, Ploom and iQOS, using the question: 'Please choose your current status for each product'; and the response options were 'never user', 'former non-regular user', 'former regular user' and 'current user'. The last three responses were combined and defined as 'ever user' of each product. Respondents who reported ever-use (at least once) of at least one type of e-cigarette were considered e-cigarette ever-users. Those who reported a number greater than zero for the question 'During the past 30 days, on how many days have you used e-cigarettes or heat-not-burn cigarettes?' were defined as e-cigarettes or heat-not burn cigarettes user in the last 30 days (page 3) *Smoking:* Participants were asked: 'Please choose your current status for combustible cigarette (boxed cigarette or roll-your-own cigarette)'; and the response options were 'never user', 'former non-regular user', 'former regular user' and 'current user'. Respondents who currently smoked combustible cigarette (boxed cigarette and/or roll-your-own cigarette) were considered current smokers. Those who reported former use and did not currently smoke either type of cigarette were considered former smokers. Those who had never smoked were considered never smokers. (page 2)
Miller et al., (2017a) [149]	*Vaping:* Participants were asked: "Have you ever used electronic cigarettes (e-cigarettes)?" (page 109) *Smoking:* To be eligible for the study, participants had to be: "smokers of ≥ 5 cigarettes per day for ≥ one year" (page 109)
Wiernik et al., (2019) [164]	Vaping: Participants were categorized into the following categories: never users, ex-users and current users of e-cig. (page 87) Smoking: Smoking status was categorized into three groups: never smokers, former smokers and current smokers. Participants were considered smokers or former smokers if they reported having consumed at least 100 cigarettes (or equivalent) and were currently or no longer smoking, respectively. At follow-up, current tobacco smoking was also reported. (page 87)

The definition of current (for both vaping and smoking) was not provided

Clinical (non-representative)

Baltz and Lach (2019) [139]	*Vaping:* Survey item for measuring vaping not included. On page 2 the authors state that the survey measured 'use of ENDS' *Smoking:* Tobacco use was assessed by asking if respondents currently used any form of tobacco on a "daily," "less than daily," or "not at all" basis. If their response was "not at all," respondents were then asked if they had ever used tobacco in the past. (page 2)
Bianco et al., (2019) [141]	*Vaping:* At each assessment visit, participants were asked whether they had used any e-cigarettes during the prior month. Participants were also asked whether they had used an e-cigarette to help them quit smoking during the previous 3 months. A variable was created combining the two questions, to establish any e-cigarette use over the study period. (page 186) *Smoking:* Smoking at least 10+ cigarettes per day (page 185)
Hefner et al., (2016) [146]	*Vaping:* Participants were classified based on current e-cigarette use (ie., use in the last 30 days versus no use) (page 4) *Smoking:* To be eligible for the study, participants were asked "if they were current or recently former (quit within past 30 days) smokers". (page 3)
Miller et al., (2017b) [149]	*Vaping:* Survey item to measure vaping was not included *Smoking:* To be eligible for the study, participants had to be a lifetime (current or former smoker) (page 6) The definition of current/former smoker was not included in the paper
Prochaska and Grana (2014) [153]	*Vaping:* Though EC use was not asked directly, an open-ended question at baseline and each follow-up assessed "all forms of tobacco use." At the time of this trial, EC were considered by the US courts to be tobacco products. (page 5) *Smoking:* daily smokers of 5 or more cigarettes/day (page 4)

How mental health diagnoses and symptom severity was assessed in participants with MHC

Study	Measures of mental health
Baltz and Lach (2019) [139]	*MHC:* Recruited at an outpatient adult mental health office. The office serves approx. 3,000 patients with psychiatric disorders including depression, schizophrenia, anxiety, and bipolar disorder, with weekly to monthly psychotherapy and medication management. (page 2)
Bandiera et al., (2016) [140]	*Depressive symptoms:* Depressive symptoms were assessed with the 10-item short-form Center for Epidemiologic Studies Depression 10 Scale (CES-D 10). This scale assesses frequency of symptoms of depression occurring over the past week, including depressed affect, positive affect, and somatic complaints. Each of the items is scored on a scale from 0 "rarely (1 day)" to 3 "most of the time (5-7 days)." The 10 items were summed and higher scores reflected higher levels of depressive symptoms. A cut off score of 10 was used to create two groups; one that reported clinically significant symptoms of a depression (score of 10 or more) and one that did not (score of 9 or less). (page 20)
Bianco et al., (2019) [141]	*MHC:* To be eligible participants had to have a mental illness diagnosis and were actively receiving mental health treatment services. Smokers with dementia, a terminal illness, or a current alcohol or drug dependence diagnosis were excluded. (page 185)
Brady et al., (2019) [142]	*MHC:* Assessed mental health status (yes, no) as having ever been diagnosed with at least one of the following: anxiety disorder, depression, bipolar disorder, schizophrenia, or alcohol or drug abuse disorder. (page 4)
Caponnetto et al., (2013) [165]	*MHC:* Study conducted in "C.T.A, Villa Chiara-Psichiatrica Riabilitativa e Ricerca", a centre for mental health rehabilitation and research. Study participants were in-patients with chronic Schizophrenia (page 449) *Symptom Severity:* Positive and negative symptoms of schizophrenia were assessed with the Scale for Assessment of Negative Symptoms (SANS) and the Scale for Assessment of Positive Symptoms (SAPS) (page 449)
Chen et al., (2017) [144]	*MHC:* SMI is used as the CMHC admission criteria and defined by 11 diagnostic categories ("Rules of Department of Mental Health, Division 30: Certification Standards, Chap. 4: Mental Health Programs", 2012). The typical SMI diagnosis distribution are schizophrenia/schizoaffective disorders (33%), mood disorders (63%), post-traumatic stress disorder (PTSD; 11%), and borderline personality disorder (8%) based on the patient profile at the studied CMHC clinics in 2014. (page 696)
Chen et al., (2018) [143]	*MHC:* A mental health symptom variable was constructed by using four questions from the Global Appraisal of Individual Needs − Short Screener (GAIN-SS). Respondents were asked to identify the time period when they last experienced: (1) "Feeling very trapped, lonely, sad, blue, depressed, or hopeless about the future?" (2) "Sleep trouble, such as bad dreams, sleeping restlessly, or falling asleep during the day?" (3) "Feeling very anxious, nervous, tense, scared, panicked, or like something bad was going to happen?" and (4) "Becoming very distressed and upset when something reminded you of the past?" Response categories were: "Past month," "2 to 12 months ago," "Over a year ago," and "Never." Respondents who experienced at least one of the four symptoms during the past month were coded as having mental health symptoms (yes/no). (page 280)

Cummins et al., (2014) [145]	*MHC:* Three MHC are listed, including anxiety disorder, depression, and other 'mental health condition'. For the purposes of this study, anyone who reported any of the three mental health items was coded as having MHC. (page 49)
Hefner et al., (2016) [146]	*MHC:* Recruitment occurred at mental health and substance abuse clinics. The survey included items about previously diagnosed mental health and substance use disorders. (page 3)
Hickling et al., (2019) [137]	*MHC:* To be eligible for the study, participants had to have "an established clinical diagnosis of schizophreniform, schizophrenia, schizoaffective disorder or bipolar disorder, or attending an early detection service in a high-risk state. (page 1034) *Symptom severity:* Psychotic and mood symptoms were measured weekly using the Positive and Negative Syndrome Scale (PANSS) and the Calgary Depression Scale for Schizophrenia (CDSS). (page 1035)
King et al., (2018) [147]	*MHC:* Participants were asked whether, within the past 6 months, a doctor had told them they had any health conditions, a list that included depression, ADHD/ADD, or other with fill-in response. *Depressive symptoms*: We used the Center for Epidemiological Studies Depression Iowa Short Form, an 11-item measure of recent depressive symptoms. Participants were asked to indicate how often they felt each way during the past week with response options rarely or none of the time (< 1 day; 0), some or a little of the time (1 to 2 days; 1), occasionally or a moderate amount of the time (3 to 4 days; 2), and most or all of the time (5 to 7 days; 3). A higher score represents greater depression. (page 68)
Kioi and Tabuchi (2018) [163]	*MHC:* Participants were asked about their health status, using the question: 'Do you have any of the following chronic diseases (for which you have received a diagnosis or are regularly visiting hospital) − hypertension, diabetes, cerebrovascular disease, asthma, atopic dermatitis, COPD, cancer, or mental disorders?'; and the response options were 'never affected', 'formerly affected', 'currently affected or regularly visiting hospital (clinic)' and 'currently affected and without ambulant treatment'. The last two responses were combined and defined as 'currently affected' for each disease. (page 3)
Meurk et al., (2016) [158]	*MHC:* Conducted in a setting who "provide services for people living with a mental disorder, including those experiencing, or at risk of, homelessness. (page 3)
Miller et al., (2017a) [149]	*SPD:* SPD was prospectively determined with the Kessler 6 (K6) Questionnaire, a validated measure of non-specific, self-perceived psychological distress over the past 30 days. We used the standard cut off score of ≥ 13 to indicate significant distress. (page 109)
Miller et al., (2017b) [148]	*MHC:* Inpatients and outpatients with schizophrenia or schizoaffective disorder were recruited. Diagnosis of schizophrenia or schizoaffective disorder was made by the inpatient or outpatient psychiatrist according to DSM-IV criteria, however, research diagnostic interviews were not utilized. (page 5)
Morean and L'Insalata (2017)	*MHC:*

[150]	Participants reported on a medical history checklist all conditions, including Eds (eating disorders), that a "doctor, nurse, or other medical professional had ever officially diagnosed [them] as having". Participants then were asked: "During your lifetime, has a doctor, nurse, or other medical professional ever OFFICIALLY diagnosed you as having an ED?" Response options included: "Yes, I have been diagnosed with Anorexia Nervosa; Yes… with Bulimia Nervosa; Yes… with Binge-Eating Disorder; Yes… with an unspecified ED; and No, I have never been diagnosed with an ED." Participants who selected ED on the checklist and who reported being diagnosed with one or more EDs were categorized as having a lifetime ED. Participants reporting a lifetime ED indicated their current ED status (no/yes) and primary diagnosis (for current ED only). Individuals who reported a current ED and primary diagnosis comprised the analytic sample. (page 78) *Eating disorder symptoms:* Participants completed the Eating Disorder Examination Questionnaire (EDE-Q 6.0) which was scored globally. (page 78)
O'Brien et al., (2015) [162]	*MHC:* Concomitant medication use was assessed at each time-point. The Anatomical Therapeutic Chemical (ATC) Classification System was used to identify participants taking medications related to mental illness. This system classifies drugs into groups according to system on which they act and their therapeutic, pharmacological and chemical properties. ATC codes indicating mental illness include: antidepressants, psychostimulants, antipsychotics, anxiolytics, hypnotics/sedatives and drugs for addictive disorders. Participants were divided into two major groups; 'mental illness participants' (those who reported use of ≥1 of the medications associated with mental illness), and 'nonmental illness participants' (no reported use of any medications associated with mental illness). (page 2)
Park et al., (2017) [151]	*SPD:* Psychological distress, was measured using the Kessler 6 (K6) Scale, a six-item questionnaire that asks respondents whether they experienced the following feelings in the past 30 days: depression, nervousness, hopelessness, restlessness or fidgetiness, worthlessness, and/or that everything was an effort. Each item is scored on a five-point Likert scale from (0, none of the time; 1, a little of the time; 2, some of the time; 3 most of the time; and 4, all of the time), and the scores were summed to yield a total K6 score between 0 and 24. (page 3)
Pratt et al., (2016) [152]	*MHC:* primary DSM-IV axis I diagnosis, based on chart review and confirmation by the community mental health center team psychiatrist, of schizophrenia, schizoaffective disorder, or bipolar disorder; SMI defined by at least moderate impairment in multiple domains of life functioning due to mental illness. (page 31)
Prochaska and Grana (2014) [153]	*MHC:* Recruited from psychiatric hospitals. Psychiatric diagnosis was determined with the Mini-International Neuropsychiatric Interview Screener (MINI) with major DSM-IV diagnostic categories of unipolar depression, bipolar depression, psychotic disorders, and alcohol or illicit drug use disorders. Measures of psychiatric symptom severity and mental health functioning were the Behavior and Symptom Identification Scale summary score (BASIS-24) and the 12-item Short Form mental health composite scale (SF-12). (page 5)
Sharma et al., (2017) [160]	*MHC:* Posts were included for analysis if the poster (someone who posts a comment on the Reddit website) of the initial thread discussed e-cigarette use in the context of mental illness, regardless of the diagnosis of mental illness (if any) of the poster. (page 3)
Sharma et al., (2018a) [161]	*MHC:* The study was conducted at three centres which provide "individuals who are experiencing MI (mental illness) and their families with social, educational, employment, recreational, and counselling support". To be eligible participants had to self-report a diagnosis of MI. (page 1674)
Spears et al., (2017) [154]	*MHC:*

Participants were asked if they had been diagnosed with a variety of medical conditions ("Have you been diagnosed by a doctor or other qualified medical professional with any of the following medical conditions?"), including the following MHCs: anxiety disorder, bipolar disorder, depression, mood disorder, schizoaffective disorder, schizophrenia, and other mental health conditions. Participants who indicated having been diagnosed with any of these conditions were coded as having a MHC. Participants were also asked whether they had ever seen a psychiatrist, psychologist, or social worker for counselling or therapy.
(page 4)

Spears et al., (2018a)

[156]

MHC:
Participants were asked if they had ever been 'diagnosed by a doctor or other qualified medical professional' with various medical conditions, including the following MHCs: 'anxiety disorder', 'bipolar disorder', 'depression', 'mood disorder', 'schizoaffective disorder', 'schizophrenia' and 'other mental health condition not included in the above'. Participants were classified as having a lifetime MHC if they reported any of these conditions.
(page 114)

SPD:
Past-month psychological distress was assessed using the Kessler-6 (K6) scale [62]. Participants were asked: 'During the past 30 days, about how often did you feel the following symptoms': 'nervous', 'hopeless', 'restless or fidgety', 'so depressed that nothing could cheer you up', 'that everything was an effort' and 'worthless'. Response options range from 0 (none of the time) to 4 (all the time), and ratings were summed for a total score. Participants were classified as having current SPD if they had K6 scores of 13 or greater.
(page 114)

Spears et al., (2018b)
[155]

MHC:
Participants were asked if they had ever been "diagnosed by a doctor or other qualified medical professional" with several medical conditions, including the following MHCs: anxiety disorder, bipolar disorder, depression, mood disorder, schizoaffective disorder, schizophrenia, and other mental conditions. Participants were coded as having MHC if they reported any of the above. Participants also indicated whether they had ever seen a psychiatrist, psychologist, or social worker for counselling or therapy.
(page 104)

Valentine et al., (2018)
[157]

MHC:
How mental health diagnoses were obtained was not reported. The study was conducted with participants from the Department of Veterans Affairs (VA)
(page 3)

Wang et al., (2018)
[107]

SPD:
The Kessler psychological distress scale is a series of six questions that ask about feelings of hopelessness, sadness, nervousness, restlessness, worthlessness, and feeling like everything is an effort in the past 30 days. Participants were asked to respond on a Likert Scale ranging from "None of the time" (score = 0) to "All of the time" (score = 4). Responses were summed over the 6 questions; persons with a score of ≥13 were coded as having serious psychological distress, and respondents with a score <13 were coded as not having serious psychological distress.
(page 1227)

Wiernik et al., (2019)
[164]

Depressive symptoms:
Depressive symptoms were assessed at baseline using the validated self-administered Center for Epidemiologic Studies Depression scale (CES-D) (Führer & Rouillon, 1989; Radloff, 1977). This 20-item questionnaire has been designed for use in community studies. The CES-D scale evaluates the frequency of depressive symptoms during the previous week (eg. I felt depressed, I felt everything I did was an effort, my sleep was restless). Responses range from 0 (hardly ever) to 3 (most of the time). The CES-D scale was used: either 1) as a binary variable based on the cut-off of ≥19 for both men and women, according to the validation of the French version (sensitivity/specificity for the diagnosis of major depression; or 2) as a continuous variable, using the whole range of CES-D scores with the interval between the 25th and the 75th percentile (ie. 10 points) as the basic unit.
(page 86)

Appendix C: Quality of intervention studies according to Villanti and colleagues' hierarchy of methodological criteria [54]

Criteria	Hickling et al., (2019) [137]	Caponnetto et al., (2013) [165]	O'Brien et al., (2015) [162]	Pratt et al., (2016) [152]	Valentine et al., (2018) [157]
Assessed outcome of interest (eg. cessation or reduction)	Yes	Yes	Yes	Yes	Yes
Assessed e-cigarette use for cessation as exposure of interest?	Yes	Yes	Yes	Yes	Yes
Appropriate study design with control or comparator?	No	No	Yes	No	No
Assessed temporality by ensuring exposure preceded the outcome?	Yes	Yes	Yes	Yes	Yes
Assessed dose and the duration of the exposure to determine degree of adherence and adequate delivery of active ingredients for a sufficient time-period to be a reasonable test of a cessation	Duration	Duration	Duration Adherence	Duration	Duration
Assessed product type and quality of e-cigarette product used (eg. its efficiency and reliability at delivering nicotine and other subjective experiences thought to aid smoking cessation?	Acceptability	No	Acceptability	Acceptability	Acceptability

Appendix D Quality assessment for studies reporting on barriers and facilitators using the Newcastle-Ottawa Scale [135]

Study	Selection	Comparability	Outcome	Result
Baltz & Lach (2019) [139]	-	*	**	Poor quality
Cummins et al., (2014) [145]	****	*	**	Good quality
Hefner et al., (2016) [146]	-	*	**	Poor quality
Hickling et al., (2019) [137]	***	*	**	Good quality
Miller et al., (2017a) [149]	***	*	**	Good quality
Miller et al., (2017b) [148]	**	*	**	Fair quality
Morean & L'insalata (2017) [150]	**	*	**	Fair quality
Pratt et al., (2016) [152]	**	-	*	Poor quality
Sharma et al., (2018) [159]	*	*	**	Poor quality
Simonavicius et al., (2017) [128]	**	*	**	Fair quality
Spears et al., (2018a) [156]	*****	*	**	Good quality
Spears et al., (2018b) [155]	****	*	**	Good quality

Appendix E Quality appraisal for qualitative studies using COREQ [53]

Study	Domain 1	Domain 2	Domain 3	Total score
Meurk et al., (2016) [158]	1	9	7	17/32
Sharma et al., (2018) [161]	4	12	7	23/32
Sharma et al., (2016) [160]	3	14	8	25/32
Smith et al., (2019) [138]	1	10	6	17/32

Appendix F: Measures of smoking and vaping

Paper ID	Measures of smoking and vaping
Population surveys	
Kapaya et al. [206]	EVP [electronic vapor product use] >3 months before pregnancy was ascertained by counting the number of women who responded affirmatively to the question "Have you ever used electronic vapor products, even one time?" (excluding those who reported use 3 months before, during, and shortly after pregnancy). EVP use around the time of pregnancy was ascertained by responses to questions about 3 specific time frames: 1) 3 months before pregnancy ("During the 3 months before you got pregnant, on average, how often did you use electronic vapor products?"); 2) during the last 3 months of pregnancy ("During the last 3 months of your pregnancy, on average, how often did you use electronic vapor products?"); and 3) 2 to 6 months after delivery (at the time the survey was administered) ("Since your new baby was born, on average, how often do you use electronic vapor products that contain nicotine?"). (page 190)
Kurti et al., 2017 [208]	Current smokers were defined as respondents who (a) reported smoking 100 lifetime cigarettes and smoking every day or some days at the time of survey completion (ie. current established smokers), or (b) did not report smoking 100 lifetime cigarettes but were smoking every day or some days at the time of survey completion (ie. current experimental smokers). Former smokers were defined as respondents who (a) reported smoking 100 lifetime cigarettes but not smoking at all at the time of survey completion (ie. former established smokers), or (b) reported previously smoking but not 100 lifetime cigarettes and were not smoking at all at the time of survey completion (ie. former experimental smokers). Never smokers were respondents who reported no lifetime or current tobacco cigarette use.

For all products, current users were defined as respondents who (a) reported having ever used the product fairly regularly and using some days or every day now (ie. current established users), or (b) reported using the product previously but not fairly regularly and using some days or every day now (ie. current experimental users). Former users were defined as respondents who (a) reported having ever used the product fairly regularly but not using at all now (ie. former established users), or (b) reported using the product previously but not fairly regularly and not using at all now (ie. former experimental users). Never-users were respondents who reported no lifetime or current use of the product in question. (page 51) |
Kurti et al., 2018 [207]	*Same as above*
Liu et al. [209]	"Have you ever used an e-cigarette, even one time?" Adults who answer in the affirmative are then asked, "Do you now use e-cigarettes every day, some days, or not at all?" Current use of e-cigarettes is defined as using e-cigarettes every day or some days. In addition, all participants are asked about their lifetime and current use of conventional cigarettes. (page 601)
Clinic surveys	
Bhandari et al. [198]	"Have you ever smoked tobacco in any form (cigarettes, cigars, pipe, hookah, etc.), even one or two puffs? Yes; No; Decline to answer

"How often have you smoked a tobacco-based product since you became pregnant? None; One or two puffs; Seldom (1 time a month); Occasionally (few times a month); Usually (few times a week); Regularly (nearly every day); Frequently (multiple times a day); Decline to answer

Have you heard of e-cigarettes (also known as electronic cigarettes, e-cigs, vape/vaping pens or pipes, or e-hookah/hookah pens or pipes)? Yes; No

Have you ever used an e-cigarette (also known as electronic cigarettes, e-cigs, vape/vaping pens or pipes, or e-hookah/hookah pens or pipes) even one or two puffs? Yes; No; Decline to answer

How often have you vaped/smoked d an e-cigarette since you became pregnant? None; One or two puffs; Seldom (1 time a month); Occasionally (few times a month); Usually (few times a week); Regularly (nearly every day); Frequently (multiple times a day); Decline to answer (online supplement) |
| Mark et al. [210] | Women were determined to be current smokers of traditional cigarettes if they had smoked within the past 30 days E-cigarette survey question not reported. |
| Oncken et al. [211] | The smoking history included questions about the number of cigarettes smoked per day recently and prior to pregnancy, number of years of smoking, smoking status of partner and friends, number of household smokers, perceived support for staying abstinent, and the composition of the household (including age and relationship to the subject). Women were also asked about their current and past use of other tobacco |

Paper ID	Measures of smoking and vaping
	products, including electronic cigarettes, number of past quit attempts, and their previous use of any adjunctive treatments to stop smoking. Because of the bilingual nature of our population and the concern that we obtain complete data, research coordinators collected answers to the questions "Have you ever tried electronic cigarettes?" Another question was "Have you tried electronic cigarettes during pregnancy?" If affirmative, the participant was asked further questions, including her reasons for use during pregnancy. (p586)
Wedel et al. [214]	Do you currently: (circle all that apply) Smoke cigarettes ____per day; Smoke cigars ____per day; Chew smokeless tobacco ____per day; Smoke pipe tobacco ____per day; Other tobacco product ____per day; Vape____mL per week Circle the names of the products that you have ever tried. Zyban/Chantix/Prescriptions; Nicotine Patches; Nicotine Lozenges; Nicotine Gum; Nicotine Inhaler; E-Cigarettes; Vape/Vaporizer/Refillable Responses included photos of products assessed (appendix)