THE UK ELECTRONIC CIGARETTE RESEARCH FORUM

cruk.org

THE UNIVERSITY of EDINBURGH UKCTAS UK Centre for Tobacco & Alcohol Studies CANCER RESEARCH UK

Electronic Cigarette Research Briefing – January 2021

This research briefing is part of a series of monthly updates aiming to provide an overview of new studies on electronic cigarettes. The briefings are intended for researchers, policy makers, health professionals and others who may not have time to keep up to date with new findings and would like to access a summary that goes beyond the study abstract. The text below provides a critical overview of each of the selected studies then puts the study findings in the context of the wider literature and research gaps.

The studies selected and further reading list do not cover every e-cigarette-related study published each month. Instead, they include high profile studies most relevant to key themes identified by the UK Electronic Cigarette Research Forum; including efficacy and safety, smoking cessation, population level impact and marketing. For an explanation of the search strategy used, please see the end of this briefing.

You can find our previous research briefings at www.cruk.org/UKECRF.

If you would prefer not to receive this briefing in future, just let us know.

This month we're running a short survey to find out more about our readers and see how we can improve this research briefing.

Please fill out it out here; it should take you less than five minutes to complete. Thank you.

Let's talk e-cigarettes – University of Oxford Podcasts

A team of Oxford researchers funded by Cancer Research UK are making a series of podcasts to discuss new e-cigarette research. The first two episodes are now available. Subscribe with iTunes or Spotify to listen to regular updates or find all episodes on the University of Oxford Podcasts site.

This podcast is part of a wider project funded by CRUK to convert the Cochrane Review of 'Electronic cigarettes for smoking cessation' into a living systematic review. More information about this project is available here.

1. Effect of Pod e-Cigarettes vs Cigarettes on Carcinogen Exposure Among African American and Latinx Smokers: A Randomized Clinical Trial

- **Study Aims**

This US study randomised African American and Latinx smokers to either a Juul e-cigarette and a six-week supply of refills (n=125) or control (n=61). The e-cigarette group received counselling at initiation and follow-ups and the control group continued smoking as normal. The primary analysis compared changes in urinary NNAL concentration at six weeks. Secondary outcomes included changes in urinary cotinine, expired CO, cardiopulmonary health and cigarette consumption up to six weeks. Self-reported cigarette and e-cigarette use at six months were also assessed in the e-cigarette group.

- **Key Findings**

At six weeks, compared with the control group, the e-cigarette group had significantly greater reductions in urinary NNAL (RR=0.36, 95%CI=0.23-0.54, p<0.001), CO (RR=0.53, 95%CI=0.42-0.68, p<0.001), respiratory symptoms (RR=0.63, 95%CI=0.47-0.85, p=0.002) and number of cigarettes smoked in the past 30 days among those still smoking (RR=0.30, 95%CI=0.20-0.43, p<0.001).

At six weeks, there were no significant differences between the control and e-cigarette groups in cotinine (p=0.17), lung function (p=0.53) and systolic (p=0.36) or diastolic (p=0.87) blood pressure.

At six weeks, 28.1% of participants in the e-cigarette group were biochemically verified exclusive e-cigarette users, 57.9% were dual users and 14% remained exclusive cigarette smokers. At six months, 24% were self-reported exclusive e-cigarette users, 33.3% were dual users, 32.3% were exclusive smokers and 10.4% used neither e-cigarettes or cigarettes.

In the e-cigarette group, compared with dual users, those who switched completely experienced greater reductions in six-week NNAL (RR=0.17, 95%CI=0.10-0.28) and CO (RR=0.33, 95%CI=0.26-0.42).

There was no significant difference in six-week NNAL reduction between dual users and exclusive smokers. However, dual users experienced significantly greater reductions in six-week CO than exclusive smokers (RR=0.58, 95%CI=0.42-0.80).

- **Limitations**

Measurements of outcomes were only taken up to six weeks meaning the long-term effects of switching from smoking to e-cigarette use cannot be determined. Changes in certain effects, for example lung function, are unlikely to be detected in this time frame.

The control group were not prompted to attempt to stop smoking. Therefore, the study cannot compare the efficacy of e-cigarettes in smoking cessation.

The device used was Juul, which uses a different method of nicotine delivery to most e-cigarettes. Therefore, the results may not be applicable to other devices.

Participants were provided the device, refills and received a financial reward for attending follow-ups. Therefore, the outcomes may not be generalisable to a real-life situation.

The sample consisted mainly of "light smokers", whose average cigarette consumption was lower than the general population. Therefore, the results may not be generalisable to heavier smokers.

Pulvers K, Nollen NL, Rice M, Schmid CH, Qu K, Benowitz NL, Ahluwalia JS. (2020). Effect of Pod e-Cigarettes vs Cigarettes on Carcinogen Exposure Among African American and Latinx Smokers: A Randomized Clinical Trial. *JAMA Netw Open*. doi: 10.1001/jamanetworkopen.2020.26324.

2. Socio-economic distribution of e-cigarette use among recent former regular smokers and current smokers at ages 25-26 in England

- **Study Aims**

This UK study reviewed data from young adults (aged 25-26) in the Next Steps cohort study between 2015-2016 who were either former regular smokers (n=346) or current smokers (n=1913). The association between education, social class and employment status with former, non-daily and daily e-cigarette use was assessed. Results were adjusted for sex, sampling measures and non-response.

- **Key Findings**

In recent former smokers, there was no overall association between education (p=0.437), social class (p=0.733) or employment status (p=0.724) and e-cigarette use. There were also no significant associations in any individual comparisons.

In current smokers, there was an overall association between social class (p=0.024) and employment status (p=0.041) and e-cigarette use. Educational attainment was not associated with e-cigarette use (p=0.501)

In current smokers, compared with those in a "high" social class, those in an "intermediate" or "lower" social class were more likely to use e-cigarettes non-daily (RRR=1.77, 95%CI=1.03-3.03, p=0.037 and RRR=1.62, 95%CI=1.00-2.61, p=0.05). Compared with those in a "high" social class, those who were classified in the "residual" category due to unemployment were less likely to use e-cigarettes daily (RRR=0.28, 95%CI=0.12-0.66).

In current smokers, those who were unemployed were less likely than those in full time employment to use e-cigarettes non-daily (RRR=0.38, 95%CI=0.18-0.81, p=0.012) and daily (RRR=0.12, 95%CI=0.02-0.56, p=0.007). Those who were classified as "economically inactive" were less likely to use e-cigarettes daily than those in full time employment (RRR=0.39, 95%CI=0.16-0.93, p=0.033).

- **Limitations**

The sample size was relatively small, particularly in the "former regular smokers" category (n=346), which may limit statistical power.

The analysis was cross sectional meaning that causality cannot be inferred from the results.

Data such as nicotine dependence, smoking intensity and reasons for using e-cigarettes were not collected. This limits the ability to assess e-cigarette use in the context of smoking cessation.

Social class was measured using the National Statistics Socio-economic classification, however the usual seven categories were condensed into three. Therefore, the full spectrum of classes is not represented by the results.

Since data collection in 2015-2016, the tobacco products directive (TPD) has been implemented, new e-cigarette devices have become available, and other tobacco control efforts have been introduced. Therefore, the results may not be reflective of the current environment.

The study was not pre-registered so the results should be considered exploratory.

Gagné T, Brown J.(2020). Socio-economic distribution of e-cigarette use among recent former regular smokers and current smokers at ages 25-26 in England. *Addiction*. doi: 10.1111/add.15345

3. Nicotine delivery and user reactions to Juul EU (20 mg/ml) compared with Juul US (59 mg/ml), cigarettes and other e-cigarette products

- **Study Aims**

This UK cross-over study compared the nicotine delivery and user experience of Juul EU (20mg/ml nicotine) with Juul US (59mg/ml nicotine) and cigarettes in dual users (n=18). After overnight abstinence and in separate sessions, participants smoked their own brand cigarette or vaped Juul EU or Juul US freely for 5 minutes. Blood nicotine levels at baseline and 2, 4, 6, 8, 10 and 30 minutes were recorded. Participants rated their urges to smoke and opinions of the product on a 1-10 scale. A subset of participants (n=7) also tested other brands of e-cigarettes.

- **Key Findings**

The maximum concentration of blood nicotine reached (C_{max}) was significantly lower for Juul EU vs Juul US (C_{max} = 3.8, IQR=2.5-7.5 vs C_{max} = 21.1, IQR=9.9-36.3, p<0.001) and Juul EU vs cigarettes (C_{max} = 3.8, IQR=2.5-7.5 vs C_{max} = 12.9, IQR=8.0-35.6, p<0.001). There was no significant difference in the time taken to reach the maximum blood nicotine concentration (T_{max}).

Compared with Juul US, Juul EU was rated lower for relieving the urge to smoke (M=9, IQR=7.8-10.0 vs M=8.5, IQR = 6.8-9.3, p=0.022) and was perceived to contain less nicotine (M=5.5, IQR=5.0-7.3 vs M=5, IQR=4.0-5.3, p=0.01). There were no significant differences in ratings of time taken for effect (p=0.205), taste (p=1.00), pleasantness or whether they would recommend to a friend (p=0.170).

When examining the changes in urges to smoke over time, there was no significant effect of product (Juul EU vs Juul US) (p=0.052).

Compared with other refillable e-cigarettes, the C_{max} was significantly lower for Juul EU (C_{max} = 10.5, SD = 5.3 vs C_{max} = 5.5, SD=3.4, p=0.023). There was no significant difference in C_{max} between cig-a-like e-cigarettes and Juul EU (p=0.047). There was no significant difference in T_{max} between Juul EU and refillable e-cigarettes or cig-a-likes.

There were no significant differences in product ratings between Juul EU and refillable or cig-a-like e-cigarettes.

- **Limitations**

The sample size was small which increases the uncertainty of estimates. Therefore, the study may not have been able to detect statistical significance in some analyses due to low power. The sample also largely consisted of males so it may not be representative of the population.

Participants tested the two Juul products in the same order, so order effects cannot be ruled out.

The effects of the different products were only measured on one occasion in dual users. Longer term follow-up studies are required to determine if the effects are sustained over time or in participants who solely use e-cigarettes.

Data on different e-cigarettes were combined into two categories – "refillables" and "cig-a-likes", despite some differences in the products. Tank devices were not tested.

The study was conducted with tobacco flavour products, so the effects of e-cigarette flavours on the outcomes cannot be determined. This may have had a particular effect on the participants rating section.

In a sensitivity analysis of the subset of participants who tested the other brands of e-cigarettes, one participant who had a baseline nicotine level of over 10mg/ml was removed, resulting in the difference in C_{max} between Juul EU and refillable e-cigarettes no longer being significant. Therefore, confidence in this estimate is limited.

Phillips-Waller A, Przulj D, Smith KM, Pesola F, Hajek P. (2020). Nicotine delivery and user reactions to Juul EU (20 mg/ml) compared with Juul US (59 mg/ml), cigarettes and other e-cigarette products. *Psychopharmacology (Berl)*. doi: 10.1007/s00213-020-05734-2.

4. How effective are electronic cigarettes for reducing respiratory and cardiovascular risk in smokers?

- **Study Aims**

This study aimed to compare the risk of cardiovascular and respiratory disease in people who smoke with people who used to smoke but now use e-cigarettes. The systematic review included three studies reporting respiratory outcomes and three studies reporting

cardiovascular outcomes. Odds ratios comparing occurrence of these outcomes were reported. Study quality was assessed using the AXIS tool.

- **Key Findings**

  Five studies were from the US and one was from Sweden. All studies surveyed the general adult population. Five studies were cross sectional and one was longitudinal in design. The studies were generally deemed acceptable in quality, with five out of six meeting at least 16 of the 20 AXIS tool criteria.

  The risk of reporting adverse respiratory symptoms (including chronic obstructive pulmonary disease, chronic bronchitis, emphysema, asthma and wheezing) was significantly lower in ex-smokers who currently used e-cigarettes compared with current smokers (ORs=0.58,95%CI=0.36-0.94 to 0.66, 95%CI=0.50-0.87, ps<0.05).

  There were no significant differences in adverse cardiovascular outcomes (including stroke, myocardial infarction and coronary heart disease) between ex-smokers who used e-cigarettes and current smokers.

- **Limitations**

  A meta-analysis of the studies was not performed. Therefore, common effects of the studies cannot be statistically verified.

  There were several differences in study designs, including the age of participants, the measurement of respiratory/cardiovascular outcomes, measurement of smoking/vaping status and the time from stopping smoking in former smokers. An analysis of study heterogeneity was not performed, so it is unclear how appropriate it is to group the results of the studies in the conclusions.

  Five out of six of the studies included in the review were cross sectional, so causality cannot be established. Reverse causality may explain the associations observed.

  Although the included studies were critically appraised, the extent to which key confounders (for example smoking pack years and comorbidities) were adjusted for is unclear.

  The confidence of the estimates is limited due to the small number of studies included in the review.

  The data in the included studies was self-reported so may be subject to recall bias.

Goniewicz ML, Miller CR, Sutanto E, Li D. (2020). How effective are electronic cigarettes for reducing respiratory and cardiovascular risk in smokers? A systematic review. *Harm Reduct J*. doi: 10.1186/s12954-020-00440-w

Overview

This month we include three studies and one systematic review, with the papers authored by researchers based in the USA and the UK.

This month's first paper focused on fourth generation nicotine salt pod system e-cigarettes and involved a randomised controlled trial to examine the harm reduction potential of these products compared with cigarettes. Participants were 186 smokers from African American and Latinx communities in two US cities. The intervention group received an e-cigarette and pods to last six weeks (5% nicotine with a choice of flavours) along with brief advice, training in using the device and assistance with planning to make a complete switch. The control group continued smoking. In person follow up was at weeks two and six with the primary outcome being reduction in urinary NNAL concentration (tobacco specific nitrosamines). There was also an incentive ($20 at baseline, $40 week two and $60 week six) to both groups for participation and engaging with follow up.

At six weeks, just over one in four (28%) participants in the intervention group had stopped smoking completely and switched to vaping, 14% were still smoking and not using an e-cigarette, and 60% were dual using. In terms of the primary outcome, there were significantly greater reductions in NNAL in the intervention compared to the control group. Within the intervention group, those that switched exclusively to vaping saw the greatest reductions in NNAL and carbon monoxide at six weeks. There was no significant change in NNAL levels between dual users and exclusive smokers, however dual users did have lower CO levels than the exclusive smokers. The study adds to the literature on tobacco harm reduction by switching from smoking to vaping and suggests, as previous research has done, that complete switching results in significant less exposure to toxicants and carcinogens than dual use. This study has also been discussed with author Professor Jasjit Ahluwalia in a recent podcast (part of the series "Let's talk e-cigarettes", funded by CRUK).

Our second article explores differences in e-cigarette use by socio-economic status (SES) among young adults in England. There is very limited research on vaping by SES among this group to date. Data were from the Next Steps cohort study which is the successor to the Longitudinal Study of Young People in England. The sample included 346 recent former regular smokers and 1913 current smokers aged 25-26. The researchers estimated the relative risks of e-cigarette use by three different measures of SES - educational attainment, social class and employment status.

The analysis didn't find any clear links between these SES measures and e-cigarette use in former smokers. For current smokers, there were some associations although they did vary between different measures of SES. The analysis found that non-daily vaping was more common among smokers employed in intermediate and lower occupations and daily use was much less frequent among the unemployed/economically inactive. Overall these findings are not particularly promising in terms of the role of vaping in reducing smoking-related health inequalities, as previous studies have found that less than daily vaping is unlikely to assist with smoking cessation. The authors point to the need for further research but also for efforts to reduce potential economic barriers in the use of vaping for smoking cessation.

This month's third article examines nicotine delivery and user reactions to Juul e-cigarettes - one brand of fourth generation nicotine salt pod system products. As bulletin readers will know, there are limits on nicotine content in vaping products in the EU and UK of up to 20mg/ml. This is not the case in the USA and a number of other countries. There has been some debate about whether the 20mg/ml limit is too low particularly for heavier smokers aiming to stop with vaping. This study was not designed to examine smoking cessation outcomes. Instead it compared the EU version of Juul

(20mg/ml nicotine) with a Juul US version (59mg/ml) and examined the pharmacokinetic profile and user ratings of both products.

A small sample of dual users (n=18) took part in the study and participated in three study visits where they provided blood samples at several intervals after A) smoking their own brand cigarette, B) Juul EU version and C) Juul US version. They also completed questionnaires. Unsurprisingly, the study found that Juul EU delivered less nicotine than Juul US or smoking. Participants reported that Juul EU was not as effective at relieving urges to smoke as the higher nicotine content US version. The researchers also compared Juul nicotine delivery with other types of vaping devices as seven of the eighteen participants had been involved in testing eight other products in a previous study. In this analysis, Juul EU delivered less nicotine than earlier generation, refillable e-cigarettes that contained the same nicotine concentration in e-liquid. Overall, the study concluded that Juul EU is less likely to be appealing to smokers and may be less effective in helping smokers to quit than Juul US and refillable products available in the EU and UK. However, these conclusions for smoking cessation in particular require further research - for example a trial involving higher and lower strength fourth generation nicotine salt pod products, if and when appropriate and feasible.

The final article this month is a systematic review of the effectiveness of e-cigarettes for reducing respiratory and cardiovascular risk in smokers. The focus was on studies that included former smokers who vape compared to current smokers. The inclusion criteria were that the study examined e-cigarettes and respiratory outcomes or cardiovascular outcomes and there were no limits within the search based on study design or year of publication. The authors were particularly interested in comparisons between former smokers currently vaping compared to current exclusive smokers and so they excluded studies where current e-cigarette users were young people or never smokers.

Six studies were included in the review - five cross-sectional (two focusing on respiratory outcomes and three cardiovascular) and one longitudinal study (focusing on respiratory health). Only one study (cross sectional, on respiratory health) was conducted outside of the USA, in Sweden. This is quite a small number of studies to draw conclusions from although they involved large samples. Study methods also varied, so direct comparisons have limitations. With these caveats in mind, there were positive results in relation to respiratory health (i.e. COPD, asthma etc) with smokers who switched to vaping reporting significantly fewer respiratory symptoms (40% lower odds overall) than continuing smokers. This was not the case for cardiovascular outcomes (coronary heart disease, stroke etc) with no significant differences observed. The authors note a number of points regarding these findings in the discussion section of the article, including that the respiratory outcomes in the studies ranged from mild to severe but the cardiovascular events were all major events such as a heart attack. In particular they call for more randomised controlled trials (such as one focusing on cardiovascular effects that we've included in a previous bulletin) and prospective cohort studies.

Other studies from December/January you might find of interest:

Patterns of use

A Retrospective Cross-Sectional Study on the Prevalence of E-cigarette Use Among College Students.

Prevalence of Vaping and Behavioral Associations of Vaping Among a Community of College Students in the United States.

Association between e-cigarette use initiated after cigarette smoking and smoking abstinence: a cross-sectional study among adolescent established smokers in the USA.

Nicotine Dependence and Stress Susceptibility in E-cigarette smokers: The Korea National Health and Nutrition Examination Survey 2013-2017.

Electronic Smoking Behavior Among Adult Males in Jordan.

Hispanics/Latinos' Cigarette and E-cigarette Use: Behavioral and Self-rated Health.

ENDS Flavor Preference by Menthol Cigarette Smoking Status among US Adults, 2018-2019.

Response to Flavored Cartridge/Pod-Based Product Ban among Adult JUUL Users: "You Get Nicotine However You Can Get It".

A qualitative study of e-cigarette use among young people in Ireland: Incentives, disincentives, and putative cessation.

Preliminary impact of the COVID-19 pandemic on smoking and vaping in college students.

E-cigarette use among Asian Americans: a systematic review.

E-cigarette use and beliefs among adult smokers with substance use disorders.

Are E-cigarette Users a Unique Group of Smokers? Latent Class Analysis of the National Youth Tobacco Survey.

Reasons why Chinese smokers prefer not to use electronic cigarettes.

E-cigarette Use and Risk Behaviors among Lesbian, Gay, Bisexual, and Transgender Adults: The Behavioral Risk Factor Surveillance System (BRFSS) Survey.

Electronic cigarette use patterns and chronic health conditions among people experiencing homelessness in MN: a statewide survey.

Prevalence and risk factors of e-cigarette use among working-age adults with and without disabilities in 2017-2018.

How widespread is electronic cigarette use in outdoor settings? A field check from the TackSHS project in 11 European countries.

Assessment of Nicotine and Cannabis Vaping and Respiratory Symptoms in Young Adults.

E-cigarette use among adults in China: findings from repeated cross-sectional surveys in 2015-16 and 2018-19.

Vapers exhibit similar subjective nicotine dependence but lower nicotine reinforcing value compared to smokers.

Why do people start or stop using e-cigarettes in Australia? A qualitative interview-based study.

Understanding pathways to e-cigarette use across sexual identity: A multi-group structural equation model.

Differences in JUUL Appeal Among Past and Current Youth JUUL Users.

Consumer Preferences for E-cigarette Flavor, Nicotine Strength, and Type: Evidence from Nielsen Scanner Data.

Mental Health and the Association between Asthma and E-cigarette Use among Young Adults in The United States: A Mediation Analysis.

Prevalence and correlates of lifetime e-cigarette use among adolescents attending public schools in a low income community in the US.

A randomised controlled single-centre open-label pharmacokinetic study to examine various approaches of nicotine delivery using electronic cigarettes.

Socio-economic distribution of e-cigarette use among recent former regular smokers and current smokers at ages 25-26 in England.

Associations between e-cigarette pack size and vaping frequency among U.S. adults.

The Relationship of E-Cigarette Use to Tobacco Use Outcomes Among Young Adults Who Smoke and Use Alcohol

Changes from 2017 to 2018 in e-cigarette use and in ever marijuana use with e-cigarettes among US adolescents: analysis of the National Youth Tobacco Survey.

Electronic cigarettes, nicotine use trends and use initiation ages among US adolescents from 1999 to 2018.

Perception

Adolescent perceptions of E-cigarette use and vaping behavior before and after the EVALI outbreak.

Descriptive and Injunctive Norms Related to E-Cigarettes.

Electronic Cigarette Users' Perspective on the COVID-19 Pandemic: Observational Study Using Twitter Data.

Effect of Exposure to e-Cigarettes With Salt vs Free-Base Nicotine on the Appeal and Sensory Experience of Vaping: A Randomized Clinical Trial.

#FlavorsSaveLives: An analysis of Twitter posts opposing flavored e-cigarette bans.

Changes in Family Physicians' Perceptions of Electronic Cigarettes in Tobacco Use Counseling Between 2016 and 2019.

Perceptions of electronic cigarettes among ethno-culturally diverse Latino adults in four US urban centers.

Disparities of perceived wellness by smoking and professional status among young individuals in Brasov, Brasov County, Romania.

Electronic cigarettes as a smoking cessation aid for patients with cancer: beliefs and behaviours of clinicians in the UK.

Gestational Women's Perceptions About the Harms of Cigarette and E-Cigarette Use During Pregnancy.

Young Adult JUUL Users' Beliefs About JUUL.

Social Media Message Designs to Educate Adolescents About E-Cigarettes.

Cessation

A Qualitative Study of Factors Influencing Adherence among Pregnant Women Taking Part in a Trial of E-Cigarettes for Smoking Cessation.

Real-world vaping experiences and smoking cessation among cigarette smoking adults.

E-cigarette use in prisons with recently established smokefree policies: a qualitative interview study with people in custody in Scotland. MAYBE

JUUL E-Cigarette Quit Attempts and Cessation Perceptions in College Student JUUL E-Cigarette Users.

E-Cigarette Use and Adult Cigarette Smoking Cessation: A Meta-Analysis.

Efficacy of Electronic Cigarettes for Smoking Cessation: A Systematic Review and Meta-Analysis.

Adults' E-Cigarette Flavor Use and Cigarette Quit Attempts: Population Assessment of Tobacco and Health Study Findings.

Nicotine replacement treatment, e-cigarettes and an online behavioural intervention to reduce relapse in recent ex-smokers: a multinational four-arm RCT. NOT SPECIFIC ENOUGH TO E-CIGS

Use of Electronic Cigarettes to Aid Long-Term Smoking Cessation in the United States: Prospective Evidence From the PATH Cohort Study.

What Motivates Smokers to Switch to ENDS? A Qualitative Study of Perceptions and Use.

Effect of Pod e-Cigarettes vs Cigarettes on Carcinogen Exposure Among African American and Latinx Smokers: A Randomized Clinical Trial

Young adults' intention to quit using JUUL.

The association between frequency of e-cigarette use and long-term smoking cessation outcomes among treatment-seeking smokers receiving a behavioral intervention.

Association between income and education with quit attempts, use of cessation aids, and short-term success in tobacco smokers: A social gradient analysis from a population-based cross-sectional household survey in Germany (DEBRA study).

Youth

Adolescents and young adults have difficulty understanding nicotine concentration labels on vaping products presented as mg/ml and percent nicotine.

Do Parents Still Matter? The Impact of Parents and Peers on Adolescent Electronic Cigarette Use.

Trends in Electronic Cigarette Use and Conventional Smoking: Quantifying a Possible "Diversion" Effect among U.S. Adolescents.

Association between age at first reported e-cigarette use and subsequent regular e-cigarette, ever cigarette and regular cigarette use.

Trends in various e-cigarette devices used by high school adolescents from 2017-2019.

Predictors of electronic cigarette use among Swedish teenagers: a population-based cohort study.

Association between observing peers vaping on campus and E-cigarette use and susceptibility in middle and high school students.

Association of electronic cigarette use with self-reported difficulty concentrating, remembering, or making decisions in US youth.

Youth Observation of E-Cigarette Use in or Around School, 2019.

Young adults' vaping, readiness to quit, and recent quit attempts: The role of co-use with cigarettes and marijuana.

High school students' use of JUUL pod flavors before and after JUUL implemented voluntary sales restrictions on certain flavors in 2018.

Electronic cigarette use and risk of cigarette and smokeless tobacco initiation among adolescent boys: A propensity score matched analysis.

Underage Youth and Young Adult e-Cigarette Use and Access Before and During the Coronavirus Disease 2019 Pandemic.

Effects of e-cigarette use on cigarette smoking among U.S. youth, 2004-2018.

Estimating the price elasticity of demand for JUUL E-cigarettes among teens.

Experimenting first with e-cigarettes versus first with cigarettes and transition to daily cigarette use among adolescents: the crucial effect of age at first experiment.

School-based e-cigarette education in Alabama: Impact on knowledge of e-cigarettes, perceptions and intent to try.

Harms and harm reduction

An Unrecognized Hazard in E-Cigarette Vapor: Preliminary Quantification of Methylglyoxal Formation from Propylene Glycol in E-Cigarettes.

Cigarette Smoke and Nicotine-Containing Electronic-Cigarette Vapor Downregulate Lung WWOX Expression, Which Is Associated with Increased Severity of Murine Acute Respiratory Distress Syndrome.

Electronic-Cigarette Use Alters Nasal Mucosal Immune Response to Live-attenuated Influenza Virus. A Clinical Trial.

Electronic Cigarettes Induce Mitochondrial DNA Damage and Trigger TLR 9 (Toll-Like Receptor 9)-Mediated Atherosclerosis.

Expression of Key Inflammatory Proteins Is Increased in Immune Cells From Tobacco Cigarette Smokers But Not Electronic Cigarette Vapers: Implications for Atherosclerosis.

Association between E-cigarette use and chronic obstructive pulmonary disease in non-asthmatic adults in the USA.

Changes in mucin production in human airway epithelial cells after exposure to e-cigarette vapor with or without nicotine.

A Longitudinal Study of Exposure to Tobacco-Related Toxicants and Subsequent Respiratory Symptoms Among U.S. Adults with Varying E-cigarette Use Status.

User-Perceived Negative Respiratory Symptoms Associated with Electronic Cigarette Use.
Reactive Oxygen Species, Mitochondrial Membrane Potential, and Cellular Membrane Potential Are Predictors of E-Liquid Induced Cellular Toxicity.

Chemical Elements in Electronic Cigarette Solvents and Aerosols Inhibit Mitochondrial Reductases and Induce Oxidative Stress.

Electronic Cigarette Liquid Constituents Induce Nasal and Tracheal Sensory Irritation in Mice in Regionally Dependent Fashion.

Cross-Sectional Association of Lifetime Electronic Cigarette Use with Wheezing and Related Respiratory Symptoms in U.S. Adults.

Exclusive E-Cigarette Users Report Lower Levels of Respiratory Symptoms Relative to Dual E-Cigarette and Cigarette Users.

The impact of vaping on periodontitis: A systematic review.

A systematic review of the impact of cigarettes and electronic cigarettes in otology.

JUUL e-liquid exposure elicits cytoplasmic Ca(2+) responses and leads to cytotoxicity in cultured airway epithelial cells.

The association between statewide vaping prevalence and COVID-19.

Flavorless vs. Flavored Electronic Cigarette-Generated Aerosol and E-Liquid on the Growth of Common Oral Commensal Streptococci.

E-cigarette aerosols containing nicotine modulate nicotinic acetylcholine receptors and astroglial glutamate transporters in mesocorticolimbic brain regions of chronically exposed mice.

Electronic Cigarette Use and Blood Pressure Endpoints: a Systematic Review.

How effective are electronic cigarettes for reducing respiratory and cardiovascular risk in smokers? A systematic review.

In vitro and in vivo cardiac toxicity of flavored electronic nicotine delivery systems.

Twenty-Four-Hour Cardiovascular Effects of Electronic Cigarettes Compared With Cigarette Smoking in Dual Users.

Addressing the challenges of E-cigarette safety profiling by assessment of pulmonary toxicological response in bronchial and alveolar mucosa models.

Cytotoxicity and Genotoxicity of E-Cigarette Generated Aerosols Containing Diverse Flavoring Products and Nicotine in Oral Epithelial Cell Lines.

Exposure to secondhand smoke among school-going adolescents in Malaysia: Findings from the tobacco and e-cigarettes survey among Malaysian adolescents (TECMA).

In vitro and in vivo cardiac toxicity of flavored electronic nicotine delivery systems.

Acute e-cig inhalation impacts vascular health: a study in smoking naive subjects.

Comparison of the biological impact of aerosol of e-vapor device with MESH technology and cigarette smoke on human bronchial and alveolar cultures.

Identification of flavouring substances of genotoxic concern present in e-cigarette refills.

The inflammatory biomarker YKL-40 is elevated in the serum, but not the sputum, of E-cigarette users.

Use of electronic cigarettes and secondhand exposure to their aerosols are associated with asthma symptoms among adolescents: a cross-sectional study.

Flavor-Toxicant Correlation in E-cigarettes: A Meta-Analysis.

Breath analysis of smokers, non-smokers, and e-cigarette users.

E-cigarette aerosol induced cytotoxicity, DNA damages and late apoptosis in dynamically exposed A549 cells.

No evidence of differences in smoking levels, nicotine dependence, carbon monoxide or motivational indices between cigarette smokers and cigarette + e-cigarette dual users in two samples.

Marketing

E-cigarette product placement and imagery in popular music videos.

Promotion of Disposable Electronic Cigarette Flavors and Topics on Twitter.

Content appealing to youth and spend characteristics of electronic cigarette video advertisements.

Association of e-cigarette advertising with e-cigarette and cigarette use among US adults.

Visual Attention to the Use of #ad versus #sponsored on e-Cigarette Influencer Posts on Social Media: A Randomized Experiment.

Differential patterns of e-cigarette and tobacco marketing exposures among youth: Associations with substance use and tobacco prevention strategies.

Electronic Cigarette Use and Metabolic Syndrome Development: A Critical Review.
Adverse effects of fetal exposure of electronic-cigarettes and high-fat diet on male neonatal hearts.

Misc

Early adolescent subchronic low-dose nicotine exposure increases subsequent cocaine and fentanyl self-administration in Sprague-Dawley rats.
Impact of the Revised European Tobacco Product Directive on the Quality of E-cigarette Refill Liquids in Belgium.
Characterization of Electronic Cigarette Warning Statements Portrayed in YouTube Videos.

Vaping: Impact of Improving Screening Questioning in Adolescent Population: A Quality Improvement Initiative.

Do e-cigarette sales reduce the demand for nicotine replacement therapy (NRT) products in the US? Evidence from the retail sales data.

Identifying current Juul users among emerging adults through Twitter feeds.
E-cigarettes and health risks: more to the flavour than just the name.

Nicotine delivery and user reactions to Juul EU (20 mg/ml) compared with Juul US (59 mg/ml), cigarettes and other e-cigarette products.
Prenatal Exposure to Electronic-Cigarette Aerosols Leads to Sex-Dependent Pulmonary Extracellular-Matrix Remodeling and Myogenesis in Offspring Mice.

UK Research Priorities for Electronic Cigarettes: A James Lind Alliance Priority Setting Partnership.

Electronic Cigarette Refill Fluids Sold Worldwide: Flavor Chemical Composition, Toxicity, and Hazard Analysis.

Search strategy

The Pubmed database is searched in the middle of each month, for the previous month using the following search terms: e-cigarette*[title/abstract] OR electronic cigarette*[title/abstract] OR ecig[title/abstract] OR (nicotine AND (vaporizer OR vaping OR vapourizer OR vaporiser OR vapouriser))

Based on the titles and abstracts new studies on e-cigarettes that may be relevant to health, the UK and the UKECRF key questions are identified. Only peer-reviewed primary studies and systematic reviews are included – commentaries will not be included. Please note studies funded by the tobacco industry will be excluded.

This briefing is produced by Alice Davies from Cancer Research UK with assistance from Professor Linda Bauld at the University of Edinburgh and the UK Centre for Tobacco and Alcohol Studies, primarily for the benefit of attendees of the CRUK & PHE UK E-Cigarette Research Forum. If you wish to circulate to external parties, do not make any alterations to the contents and provide a full acknowledgement. Kindly note Cancer Research UK cannot be responsible for the contents once externally circulated.